

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

WAVELYNX TECHNOLOGIES CORP.
Petitioner,

v.

ASSA ABLOY IDENTIFICATION TECHNOLOGY GROUP AB
Patent Owner.

Case No. IPR2023-00730
Patent No. 7,439,862

DECLARATION OF EMMANOUIL TENTZERIS, PH.D.

TABLE OF CONTENTS

I.	INTRODUCTION AND SUMMARY OF OPINIONS.....	1
II.	PROFESSIONAL BACKGROUND and qualifications.....	3
III.	MATERIALS REVIEWED AND CONSIDERED	9
IV.	my understanding of legal standards	9
	A. Anticipation	11
	B. Obviousness.....	11
V.	PERSON OF ORDINARY SKILL IN THE ART	14
VI.	BACKGROUND AND STATE OF THE ART.....	16
	A. Radio Frequency Identification Readers	16
	B. Multi-Frequency RFID Readers.....	20
	C. Design Considerations For Multi-Frequency Readers.....	21
VII.	THE '862 PATENT.....	30
	A. Overview	30
	B. Prosecution History	32
	C. Priority.....	33
VIII.	CLAIM INTERPRETATION	34
IX.	THE CHALLENGED CLAIMS ARE UNPATENTABLE IN LIGHT OF THE PRIOR ART IDENTIFIED IN THE PETITION	35
	A. Ground 1: Conlin Renders Obvious Claims 1-6, 14, 16, 17, and 19-21 of the '862 Patent	35
	1. Conlin.....	35
	2. The '677 Provisional Application.....	40
	3. The '677 Application Provides Support for At Least One Claim in Conlin.....	42
	4. Claim 1	46
	5. Claim 2: “The antenna array of claim 1, wherein said first low carrier frequency is nominally 125 kHz.”	65
	6. Claim 3: “The antenna array of claim 2, wherein said second high carrier frequency is about 13.56 MHz.”	66

7.	Claim 4: “The antenna array of claim 1, further comprising a reader housing containing said first and second antennas.”	66
8.	Claim 5	68
9.	Claim 6: “The antenna array of claim 5, further comprising a reader housing containing said first and second antennas.”	72
10.	Claim 14	73
11.	Claim 16: “The RFID reader of claim 14, wherein said signal generator includes a discrete first signal generator coupled with said first reader antenna for generating signals for transmission from said first reader antenna and a discrete second signal generator coupled with said second reader antenna separate from said discrete first signal generator for generating signals for transmission from said second reader antenna.”	75
12.	Claim 17	76
13.	Claim 19: “The RFID reader of claim 17, wherein said receiver electronics includes discrete first receiver electronics coupled with said first reader antenna for conditioning signals received by said first reader antenna and discrete second receiver electronics coupled with said second reader antenna separate from said discrete first receiver electronics for conditioning signals received by said second reader antenna.”	78
14.	Claim 20	78
B.	Ground 2: Conlin in view of Walton Renders Obvious Claims 7, 9-11, 13, 22-24, and 26 of the ’862 Patent	82
1.	Walton	82
2.	Claim 7:	86
3.	Claim 9	92
4.	Claim 10: “The antenna array of claim 9, further comprising a reader housing containing said first and second antennas.” ...	108
5.	Claim 11:	108
6.	Claim 13: “The antenna array of claim 9, wherein said first and second reader antennas are arranged in an overlapping	

	arrangement simultaneous with said opposing magnetic flux arrangement.”	108
7.	Claim 22:.....	109
8.	Claim 23	112
9.	Claim 24: “The antenna array of claim 23, wherein said first loop has a first area, said second loop has a second area, and said first and second loops are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”	116
10.	Claim 26: “The antenna array of claim 23, wherein said first and second loops are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.”	116
C.	Ground 3: The RFID Handbook in view of the Davis Presentation Renders Obvious Claims 1-6 and 14-21 of the ’862 Patent.....	116
1.	Overview of RFID Handbook.....	116
2.	Overview of Davis Presentation	120
3.	Claim 1	125
4.	Claim 2: “The antenna array of claim 1, wherein said first low carrier frequency is nominally 125 kHz.”	138
5.	Claim 3: “The antenna array of claim 2, wherein said second high carrier frequency is about 13.56 MHz.”	138
6.	Claim 4: “The antenna array of claim 1, further comprising a reader housing containing said first and second antennas.” ...	139
7.	Claim 5	140
8.	Claim 6: “The antenna array of claim 5, further comprising a reader housing containing said first and second antennas.” ...	144
9.	Claim 14	144
10.	Claim 15: “The RFID reader of claim 14, wherein said signal generator is an integrated signal generator including integral means for generating signals for transmission from said first and second reader antennas.”	147

11.	Claim 16: “The RFID reader of claim 14, wherein said signal generator includes a discrete first signal generator coupled with said first reader antenna for generating signals for transmission from said first reader antenna and a discrete second signal generator coupled with said second reader antenna separate from said discrete first signal generator for generating signals for transmission from said second reader antenna.”	153
12.	Claim 17.....	154
13.	Claim 18: “The RFID reader of claim 17, wherein said receiver electronics is integrated receiver electronics including integral means for conditioning signals received by said first and second reader antennas.”	156
14.	Claim 19: “The RFID reader of claim 17, wherein said receiver electronics includes discrete first receiver electronics coupled with said first reader antenna for conditioning signals received by said first reader antenna and discrete second receiver electronics coupled with said second reader antenna separate from said discrete first receiver electronics for conditioning signals received by said second reader antenna.”	161
15.	Claim 20	162
D.	Ground 4: The RFID Handbook in view of the Davis Presentation and Walton Renders Obvious Claims 7, 9-11, 13, 22-24, and 26 of the ’862 Patent.....	164
1.	Claim 7: “The antenna array of claim 5, wherein said first reader antenna has a first area, said second reader antenna has a second area, and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.....	164
2.	Claim 9	169
3.	Claim 10: “The antenna array of claim 9, further comprising a reader housing containing said first and second antennas.” ...	187
4.	Claim 11:.....	187
5.	Claim 13: “The antenna array of claim 9, wherein said first and second reader antennas are arranged in an overlapping	

	arrangement simultaneous with said opposing magnetic flux arrangement.”	187
6.	Claim 22:.....	188
7.	Claim 23	190
8.	Claim 24: “The antenna array of claim 23, wherein said first loop has a first area, said second loop has a second area, and said first and second loops are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”.....	194
9.	Claim 26: “The antenna array of claim 23, wherein said first and second loops are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.”	194
X.	CLAIM LISTING	196

I, Emmanouil Tentzeris, declare:

I. INTRODUCTION AND SUMMARY OF OPINIONS

1. I have been retained by WaveLynx Technologies Corporation (“Petitioner”), to provide analysis and expert opinions on various topics, including: (1) an overview of the art related to U.S. Patent No. 7,439,862 (“the ’862 patent”), the patent challenged in this proceeding; (2) the level of ordinary skill in the art; and (3) the patentability of claims 1-7, 9-11, 13-20, 22-24, and 26 (the “Challenged Claims”) of the ’862 Patent. In particular, for the purposes of this declaration, I have been asked to provide an analysis of the scope and content of the ’862 Patent relative to the prior art at the time of the ’862 Patent’s priority date (which I have been asked to assume is May 18, 2004 (hereinafter, the “priority date”), and to provide my opinions from the perspective of a person having ordinary skill in this art (which I will refer to as a “POSITA”).

2. This declaration summarizes the opinions that I have formed to date and is based on personal knowledge, skill, experience, and review of materials read and considered in connection with this opinion. I may modify my opinions if necessary, based on further review and analysis of information provided to me at a later date. If asked to give my sworn testimony in a deposition regarding the contents of this declaration, I will do so.

3. Based on the level of ordinary skill in the art, which I describe in more detail below, it is my opinion that the challenged claims of the '862 Patent are un-patentable based on at least the following separate bases:

Basis	Claims	Statutory Basis	Reference(s)
1.	1-6, 14, 16, 17, 19, and 20	§103	U.S. Patent Publication No. 2005/0204167 (“Conlin”) (EX1006)
2.	7, 9-11, 13, 22-24, and 26	§103	Conlin in view of U.S. Patent No. 4,600,829 (“Walton”) (EX1023)
3.	1-6, 14-20	§103	“RFID Handbook, Fundamentals and Applications in Contactless Smart Cards and Identification” (“the RFID Handbook”) (EX1008) in view of “Migration Strategies (With an Emphasis On Moving from 125 kHz Prox to 13.56 MHz Contactless Smart Card Technology)” (“the Davis Presentation”) (EX1011)
4.	7, 9-11, 13, 22-24, and 26	§103	RFID Handbook in view of the Davis Presentation and Walton

4. I reserve the right to supplement this declaration as permitted to address any issues raised by expert(s) engaged by Patent Owner or resulting from further discovery. Additionally, I reserve my right to supplement this section if new information that would affect the Priority Date becomes available to me.

5. I am being compensated for my time at my standard rate of \$795.00 per hour, plus actual expenses. My compensation is not dependent in any way upon the outcome of the *inter partes* review of the '862 patent.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

6. My complete qualifications and professional experience are described in my curriculum vitae, a copy of which is provided as Exhibit 1005. The following is a brief summary of my relevant qualifications and professional experience.

7. I am currently a Professor with tenure in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. I received my Bachelor of Science degree in Electrical Engineering from the National Technical University of Athens in Greece in 1992. I received my Master's degree and Ph.D from the University of Michigan at Ann Arbor in 1994 and 1998, respectively. A complete list of my academic positions, activities, and publications is set out in my CV, attached. (EX1005).

8. Between 1991 and 1992, I was a research assistant in the Microwave Lab at the National Technical University of Athens, Greece. From 1992 to 1998, I was a research assistant in the Radiation Laboratory at the University of Michigan, Ann Arbor. I became an assistant professor at the School of Electrical and Computer Engineering at Georgia Technical Institute in 1998, lasting until I became an Associate Professor in the same School in 2004. I then served as Associate Professor until my promotion to Professor in 2016, a title I have held

since then. Also in 2016, I was appointed as the Ken Byers Professor in Flexible Electronics.

9. As described in my CV, I have more than 30 years of industry and academic experience. I have experience with radio frequency identification (“RFID”) and electromagnetic systems, including extensive experience relating to the use of radio and electromagnetic waves. As a professor of Electrical and Computer Engineering, I have taught courses in Electromagnetics and courses relating to RFID technologies. A complete list of my teaching positions, honors, and classes taught is set out in my CV, EX1005. As a professor, I collaborated with over 130 Undergraduate, Masters and Doctoral students, as well as visiting students, post-doctoral fellows, and other researchers, including on topics such as “Hybrid Electromagnetic/Mechanical Modeling, Design and Optimization of Antenna Arrays on Composite Materials,” “An Interference-Cancellation Receiver for Multi-Band and Multi-Standard Wireless Communication Systems”, and “Design and Optimization of RFID Compact Antennas.”

10. Throughout my career, I have received a variety of awards. I am a Fellow of IEEE, a member of the MTT-15 Committee, an Associate Member of European Microwave Association (EuMA), a Fellow of the Electromagnetics Academy, and a member of Commission D, URSI and of the Technical Chamber of Greece. In recognition of my world-leading achievements in the area of RFIDs,

I served as an IEEE C-RFID (Committee on RFID technologies) Distinguished Lecturer from 2016-2022 and I served as an IEEE MTT Distinguished Microwave Lecturer (DML) from 2010-2012. I have won awards for my contributions in developing various technologies, including RFID systems operating at different frequencies and RFID applications with different power constraints. My achievements include the following:

- IEEE fellow — a distinction reserved for select IEEE members whose extraordinary accomplishments in any of the IEEE fields of interest are deemed fitting of this prestigious grade elevation. IEEE, About the IEEE Fellow Program, <http://www.ieee.org/membership/fellows/>.
- 2021 IEEE Antennas and Propagation Symposium (APS) Best Student Paper Award (co-authored)
- 2019 Humboldt Research Prize
- 2019 IEEE APS Conference Co-Chair
- 2018 Intel IEEE ECTC 2018 Best Student Paper Award
- 2015-present IEEE CRFID Distinguished Lecturer
- 2010-2012 IEEE MTT-S Distinguished Microwave Lecturer
- 2017 Georgia Tech Outstanding Achievement in Research Program Development Award
- 2017 Archimedes IP Salon Gold Medal

- 2016 Bell Labs Prize Third Award
- 2015 IET Microwaves, Antennas and Propagation Premium Award
- 2014 Georgia Tech ECE Distinguished Faculty Achievement Award
- 2014 IEEE RFID-TA Best Student Paper Award
- 2013 IET Microwaves, Antennas and Propagation Premium Award
- 2012 Finland Distinguished Professor (Fi.Di.Pro.) Award
- 2012 Architecture Award of Excellence, Architecture World Summit
- 2010 IEEE Antennas and Propagation Society Piergiorgio L. E. Uslenghi Letters Prize Paper Award
- 2010 Georgia Tech Senior Faculty Outstanding Undergraduate Research Mentor Award
- 2009 IEEE Transactions on Components and Packaging Technologies Best Paper Award
- 2009 IEEE Antennas and Propagation Symposium (APS) Second Best Student Paper Award
- 2009 E.T.S. Walton Award from Science Foundation Ireland
- 2007 IEEE Antennas and Propagation Symposium (APS) Best Student Paper Award
- 2007 IEEE International Microwave Symposium (IMS) Third Best Student Paper Award

- 2007 IEEE International Symposium on Antennas and Propagation (ISAP) Poster Presentation Award
- 2006 Asian-Pacific Microwave Conference (APMC) Award
- 2006 IEEE-MTT Outstanding Young Engineer Award
- 2004 IEEE Transactions on Advanced Packaging Commendable Paper Award
- 2003 NASA Godfrey “Art” Anzic Collaborative Distinguished Publication Award
- 2003 IBC International Educator of the Year Award
- 2003 IEEE-CPMT Outstanding Young Engineer Award
- 2002 International Conference on Microwave and Millimeter-Wave Technology Best Paper Award (Beijing, China)
- 2002 Georgia Tech-ECE Outstanding Junior Faculty Award
- 2001 ACES Conference Best Student Paper Award
- 2000 NSF CAREER Award
- 1999 Technical Program Co-Chair of the 54th ARFTG Conference, Atlanta, GA
- 1997 Best Paper Award, International Hybrid Microelectronics and Packaging Society
- 1989 Papastavridios Greek Mathematics Excellence Fellowship

- 1988-1992 Greek Government Academic Excellence Fellowships

11. In Google scholar, there are over 25,924 citations to my work and my work has an h-index of 80. An h-index represents the number of papers with the same number of citations, meaning I have over 80 papers with 80 citations.

12. I have authored or contributed to over 30 books and 835 refereed journal and conference papers; spoke in over 140 presentations, many of which relate to antenna arrays, RFID systems, and other modes of wireless communication and electronics design. A complete list of my publications and conference presentations is included in my curriculum vitae (EX1005).

13. I am a named inventor on 20 patents in the US and in Europe. In particular, I am a named inventor on patents relating to antenna design, RF systems, and means of reducing signal interference in RF applications. A complete list of my patents and published applications is included in my curriculum vitae (EX1005).

14. In addition to gaining expertise via my academic training, professional experiences, and research accomplishments described above, I have kept abreast of various sub-disciplines within the RFID space, such as locating technologies, by reading technical literature, attending and presenting at conferences, and attending and presenting at symposia. I have served as an editor for various journals and participated in the peer review process for various technical journals and

conferences, and have reviewed manuscripts submitted by other scholars relating to RFID. I have contributed further to the profession by chairing conference committees and planning conferences and panels. Furthermore, I have collaborated with or have communicated with many of the scholars and engineers in the field of RFID systems.

15. I am not an attorney and offer no legal opinions, but in the course of my work, I have had experience studying and analyzing patents and patent claims from the perspective of a POSITA.

III. MATERIALS REVIEWED AND CONSIDERED

16. My findings, as explained below, are based on my years of education, research, experience, and background in the field of RFID systems and electromagnetism, as well as my investigation and study of relevant materials for this declaration. When developing the opinions set forth in this declaration, I assumed the perspective of a POSITA, as set forth in Section IX below. In forming my opinions, I have also reviewed and considered all of the exhibits and prior art references I discuss in this declaration.

IV. MY UNDERSTANDING OF LEGAL STANDARDS

17. I have not been asked to offer an opinion on the law; however, as an expert assisting the Board in determining patentability, I understand that I am

obliged to follow existing law. I have therefore been asked to apply the following legal principles to my analysis.

18. I understand that “*inter partes* review” (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent’s claims based on prior-art patents and printed publications.

19. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims of the ’862 patent are unpatentable by a preponderance of the evidence. I understand that “preponderance of the evidence” means that a fact or conclusion is more likely true than not true.

20. I understand that determining whether a particular patent or printed publication constitutes prior art to a challenged patent claim can require determining the priority date to which the challenged claim is entitled. I understand that for a patent claim to be entitled to the benefit of the filing date of an earlier application to which the patent claims priority, the earlier application must have described the claimed invention in sufficient detail to convey with reasonable clarity to the POSITA that the inventor had possession of the claimed invention as of the earlier application’s filing date. I understand that a disclosure that merely renders the claimed invention obvious is not sufficient written description for the claim to be entitled to the benefit of the filing date of the application containing that disclosure.

21. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (novel—*i.e.*, not anticipated) and not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Anticipation

22. I understand that, for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every limitation of the claim must be found, expressly or inherently, in a single prior-art reference. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSITA would have understood the reference to disclose the limitation based on inferences that a POSITA would reasonably be expected to draw from the explicit teachings in the reference when read in light of the POSITA’s knowledge and experience.

23. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the reference, regardless of whether a POSITA recognized the presence of that limitation in the prior art.

B. Obviousness

24. I understand that a patent claim may be unpatentable if it would have been obvious in view of a single prior-art reference or a combination of prior-art references.

25. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a whole would have been obvious to a POSITA at the time the invention was made. Specifically, I understand that the obviousness question involves a consideration of:

- the scope and content of the prior art;
- the differences between the prior art and the claims at issue;
- the knowledge of a person of ordinary skill in the pertinent art; and
- if present, objective factors indicative of non-obviousness, sometimes referred to as “secondary considerations.” (To my knowledge, the Patent Owner has not asserted any such secondary considerations with respect to the ’862 patent.)

26. I understand that in order for a claimed invention to be considered obvious, a POSITA must have had a reason for combining teachings from multiple prior-art references (or for altering a single prior-art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

27. I further understand that in determining whether a prior-art reference would have been combined with other prior art or with other information within the knowledge of a POSITA, the following are examples of approaches and rationales that may be considered:

- combining prior-art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- use of a known technique to improve similar devices in the same way;
- applying a known technique to a known device ready for improvement to yield predictable results;
- applying a technique or approach that would have been “obvious to try,” *i.e.*, choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;
- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention. I understand that this teaching, suggestion or motivation may come from a prior-art reference or from the knowledge or common sense of one of ordinary skill in the art.

28. I understand that for a single reference or a combination of references to render the claimed invention obvious, a POSITA must have been able to arrive at the claimed invention by altering or combining the applied references.

V. PERSON OF ORDINARY SKILL IN THE ART

29. I have been informed and understand that for purposes of assessing whether prior-art references disclose every element of a patent claim (thus “anticipating” the claim) and/or would have rendered the claim obvious, the patent and the prior-art references must be assessed from the perspective of a POSITA, based on the understanding of that person at the time of the patent claim’s priority date. I have been informed and understand that a POSITA is presumed to be aware of all pertinent prior art and the conventional wisdom in the art, and is a person of ordinary creativity. I have applied this standard throughout my declaration.

30. The ’862 patent involves technology in the field of multi-frequency RFID readers. I have been asked to provide my opinions as to the state of the art in this field by late 2003. I use this timeframe because the face of the ’862 patent indicates an earliest claimed priority date of the May 18, 2004 filing date of a nonprovisional application, and because Patent Owner has claimed an earlier conception date of February 12, 2004 in related district court litigation for certain claims. EX1001, Title Page, (63); EX1022, at 13. I am unaware of any evidence Patent Owner has provided to establish any earlier conception date, and moreover,

the '862 patent issued from a December 2004-filed CIP application to the May 2004 application. EX1001, Title Page, (63). The December 2004 application contains matter not supported by the May 2004 filing. *See* §VII.C, *infra*. However, out of an abundance of caution, whenever I offer an opinion in this declaration about the knowledge of a POSITA, the manner in which a POSITA would have understood the claims of the '862 patent or its description, the manner in which a POSITA would have understood the prior art, or what a POSITA would have been led to do based on the prior art, I am referencing the 2003 timeframe, even if I do not say so specifically in each case.

31. In my opinion, a POSITA at the time of the alleged invention would have had at least an undergraduate degree in electrical engineering, or equivalent education, and at least two years of work experience in the field of access control.

32. By late 2003, I held a Ph.D and I had 10+ years of experience with RFID systems and radio frequency communication. Therefore, I was a person of more than ordinary skill in the art during the relevant timeframe. However, I worked with many people who fit the characteristics of the POSITA, and I am familiar with their level of skill. When developing the opinions set forth in this declaration, I assumed the perspective of a person having ordinary skill in the art, as set forth above.

VI. BACKGROUND AND STATE OF THE ART

33. The technical background presented below reflects the state of the art that a POSITA would have had knowledge of and understood prior to and by late 2003. I rely on, and incorporate as applicable (even if not expressly mentioned below in Section IX), the following disclosures and opinions to support my opinions in this Declaration, including those opinions relating to how the prior art discloses and/or suggests the challenged claims of the '862 Patent and how and why a POSITA would have combined the disclosures and suggestions from that prior art. The concepts below would have been within the knowledge and mindset of a POSITA before and as of late 2003.

A. Radio Frequency Identification Readers

34. Radio Frequency Identification (“RFID”) is a long-known form of wireless communication in which signals or other information are transmitted and received along the radio wave band of the electromagnetic spectrum in order to identify an object or person. RFID has long been used in systems that control access to a location, building, or other resource. Typically such systems would include an RFID transponder, such as a keycard carried by a person, and an RFID reader, such as a device attached to a wall outside of a secure room or building. By placing the RFID transponder near the RFID reader, one or more signals is sent between the transponder and reader along radio waves, and the reader then sends

data to an access controller, which, if the information transmitted indicates that the person holding the transponder has access privileges, will grant access, for example by unlocking a door. Such technology was long known and used before late 2003. *See, e.g.*, EX1008, at 5-6, 104-135; EX1010 at 10-14; EX1011 at 4; EX1009; EX1033.

35. RFID systems used for access control may send and receive signals along different frequencies within the radio wave band of the electromagnetic spectrum. For example, RFID transponders that send data signals along a range of 100 to 150 kHz, and in particular 125kHz (sometimes referred to as “low-frequency readers”), have long been used in the field of access control, and indeed, were the predominant type of RFID reader before 2004. (*See, e.g.* EX1010 at 25; EX1011 at 4, 11; *see also* EX1008, at 54-55. Transponders communicating at 125 kHz were often referred to as “proximity”—or “prox”—cards. (*See, e.g.*, EX1011 at 4; EX1001 at 2:6-14.) These cards and associated systems, although widely used, were known to have several disadvantages, including lack of a standardized transmission protocol (*i.e.*, could use different proprietary protocols of different vendors, which could lead to interoperability issues), relatively low data storage capacity, and security vulnerabilities. (*See, e.g.* EX1011 at 4; EX1010 at 25).

36. By the mid-1990’s, RFID transponders that communicated at “high-frequency,” and in particular 13.56 MHz, began to be implemented. Such

transponders were often referred to as “smart” cards, and had several known advantages over low-frequency “prox” cards. For example, smart cards utilized standardized transmission protocols (such as ISO14443A/B and ISO15693), had greater data storage capacity, and had greater security capabilities. (*See, e.g.*, EX1011 at 4-5, 7-11; EX1010 at 25; EX1008, at 63-78.) A summary of these advantages can be seen in the following presentation published in July 2003:

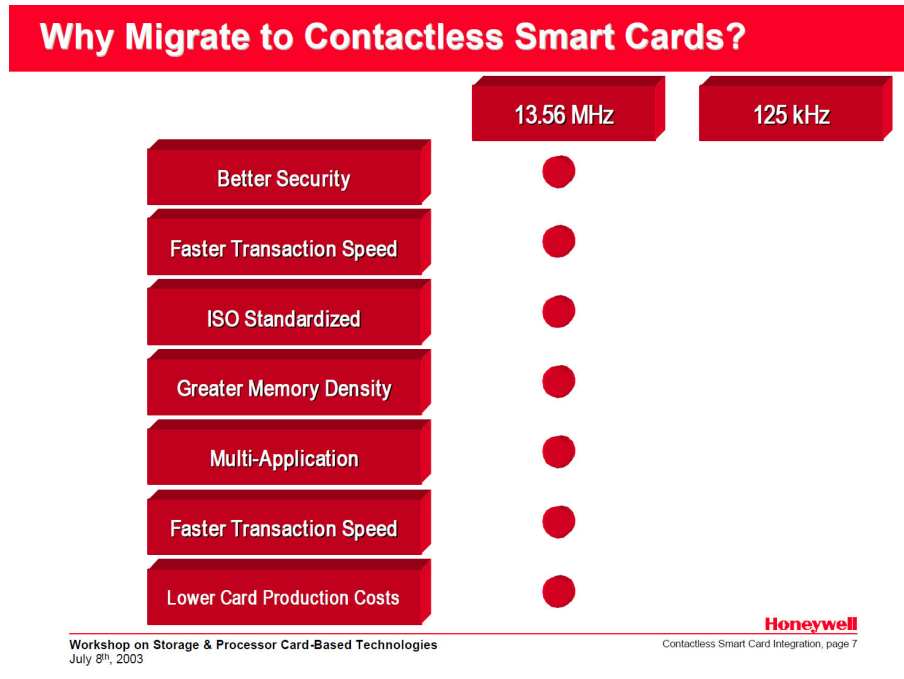
What is Contactless Smart Card Technology?

- **Contactless Smart Cards**
 - Requires no physical contact between a card and reader
 - Operates at 13.56 MHz
 - Typical operating distance from 2” to 6”
 - Maximum operating distance of 39”
 - Packaged in cards, key fobs, stickers, labels, and more
 - Data content from 256 bits to 4k bytes and more
 - Memory can be segmented for *multi-application* use
 - Very high security
 - Supports true read/write on the fly
 - ISO Standardized (ISO 14443A/B & 15693)

Honeywell

Workshop on Storage & Processor Card-Based Technologies
July 8th, 2003

Contactless Smart Card Integration, page 5



(EX1011 at 5, 7.)

37. Thus, before the priority date to which the '862 patent is entitled, both low-frequency RFID readers, including those transmitting at 125 kHz and compatible with prox cards, and high-frequency RFID readers, including those transmitting at 13.56 MHz and compatible with smart cards, were well known and used in the art. (*See, e.g.*, EX1011, at 4-5, 11; EX1010, at 21-22, 25; EX1008, at 8-9, 49-55, 63-78, 79-88, 97-101, 104-135, 137-142; EX1033, at 2 (125 kHz reader); EX1009, at 2 (13.56 MHz reader); EX1001, at 2:1-21; EX1014; EX1006, ¶¶[0026], [0046]; EX1007, at 5-7, 14-20, 31, 33, 41-42, 50-52, 56; EX1023, at 3:39-43; EX1022, at 91-96; EX1012; EX1013; EX1015; EX1016; EX1025, at 1-7; EX1011; EX1036, at 1-3, 6-7; EX1034.)

B. Multi-Frequency RFID Readers

38. Given the widespread existing use of low-frequency prox cards and the known advantages of high-frequency smart cards, it was well known before the any priority date to which the '862 patent may be entitled that it would be advantageous to use a RFID reader that could communicate at both frequencies, and thus could be used with both types of cards. This would allow, for example, a company to keep using its existing legacy low-frequency prox cards while “migrating” to high-frequency smart cards and their associated benefits, thus avoiding the potentially substantial costs of immediately replacing all legacy prox cards. (*See, e.g.*, EX1011, at 1, 8-11; EX1010, at 34; EX1007 at 5, 14 (Fig. 10); EX1006, ¶[0026]; EX1007, at 5,7.)

39. Indeed, such multi-frequency readers were known, available for purchase, and in public use before the any priority date to which the '862 patent may be entitled. (*See, e.g.*, EX1010 at 34; EX1006 at ¶¶[0026], [0037]; EX1007 at 5, 7-8; EX1036, at 1-3, 6-7; EX1011, at 21-22; EX1032; EX1027; EX 1028; EX1022, at 87-90.) For example, by at least early 2001, Cross Point was offering what it claimed to be the “world’s 1st dualband RFID reader” (EX1036, at 1, 6-7), “supporting world wide RFID standards on 125kHz and 13.56MHz,” (EX1036, at 1-3). By 2003, multi-frequency readers were available from “a few vendors”

(EX1011, at 22), including TI, with their S4100 Multi-Function Reader Module (EX1014; EX1036, at 1, 4-5).

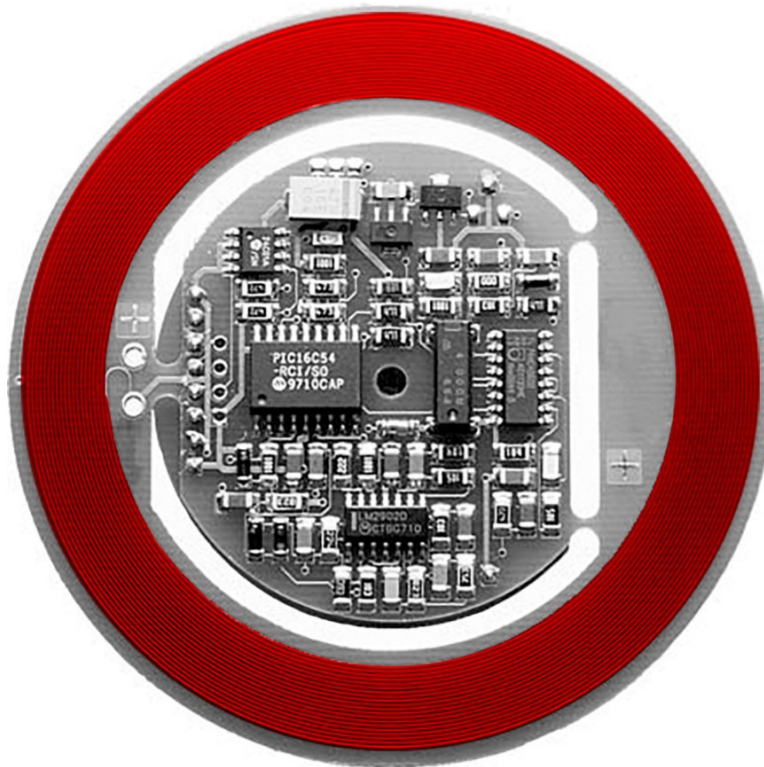
40. Accordingly, and as explained further below, it was known before the any priority date to which the '862 patent may be entitled that it would be advantageous to incorporate both high-frequency and low-frequency communication capabilities into a single RFID reader. It was further known that such a reader could be readily assembled using conventional RFID components such as antennas and associated circuitry, which were all rudimentary and well known in the prior art.

C. Design Considerations For Multi-Frequency Readers

41. It was well known before the any priority date to which the '862 patent may be entitled that an RFID reader would necessarily include certain conventional components such as an antenna for transmitting and receiving signals. For example, loop antennas were a known common design choice for both low-frequency and high-frequency RFID readers. Such antennas consist of many windings of a tightly wound coil, and would be placed on, or embedded within, the reader's circuit board. (*See, e.g.*, Ex1007, at 35-36, 42-44; EX1008 at 8-9, 92, 99, 140; EX1012; EX1013, at 1-3; EX1015, at 1, 3; EX1016; EX1027, at 2-4.)

42. It was further known that while antennas for low-frequency readers typically comprised a high number of windings, antennas for high-frequency

readers typically comprised a low number of windings due to their higher frequency. *See, e.g.*, EX1008, at 8-9, 92; EX1012; EX1013, at 1-3; EX1015, at 1, 3; EX1016; EX1027, at 3.) For example, below on the left is the circuit board for the low-frequency “easy-key” reader, which utilized an antenna (in red) with a high number of windings on the perimeter, and on the right is a circuit board for the high-frequency “MIFARE” reader, which utilized an antenna (in blue) with a lower number of windings integrated within the circuit board:





(EX1008, at 9, 92, 137-142; *see also* EX1016, at 1-7.)

43. It was also known before any priority date to which the '862 patent may be entitled that when using two antennas in a single RFID reader, it would be advantageous to arrange the two antennas in relatively close proximity to each other so as to minimize the total bulkiness of the reader. *See* EX1023, at Figs. 2A, 2B; EX1025, at 6; EX1027. However, it was also known that antennas must be positioned such that magnetic interactions between them are minimized so as not to disrupt the transmission and reception of signals by the antennas, while still ensuring that signals may effectively be sent between the reader and credential cards. EX1008, at 14-35; EX1023, 5:21-43; EX1024, at 1:31-40, 2:48-3:2.

44. As explained further below, it was well known that both aims would be accomplished by positioning the antennas along axes that are parallel to each

other (to minimize the size of the reader), yet are only partially overlapping (to minimize magnetic interactions). Indeed, the locations of increased and decreased magnetic field strengths surrounding a coil antenna was well known in the prior art prior to the filing of the '862 patent, including the magnetic field interactions between two antennas arranged in a parallel configuration. (*See, e.g.*, EX1008, at 14-35; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2.)

45. It was also very well known how magnetic fields operate. *Id.* For example, a POSITA would know that, per Lenz's Law and Ampere's law, a magnetic field is generated by a current moving through a wire, and that the magnetic field would radiate around the wire in a clockwise direction around the coil in relation to the direction of the current, as shown in Fig. 4.3 of the RFID Handbook. EX1008, at 16. On the plane of the reader antenna, the magnetic field flows perpendicularly. *Id.*

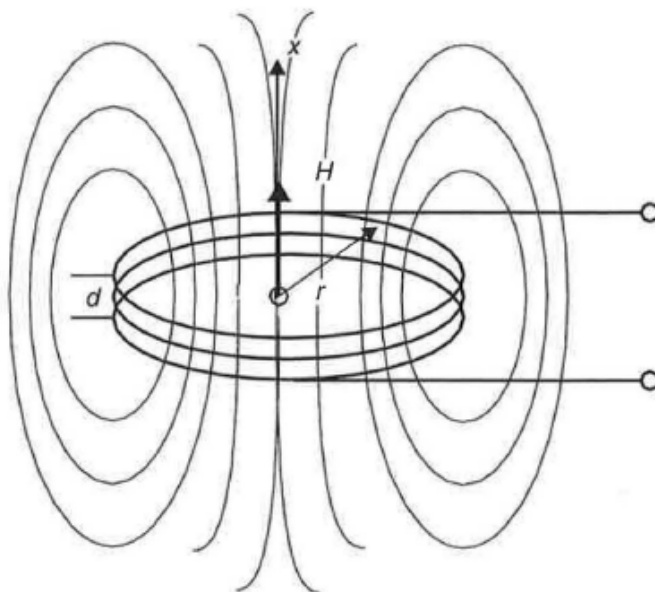


Figure 4.3 The path of the lines of magnetic flux around a short cylindrical coil, or conductor loop, similar to those employed in the transmitter antennas of inductively coupled RFID systems

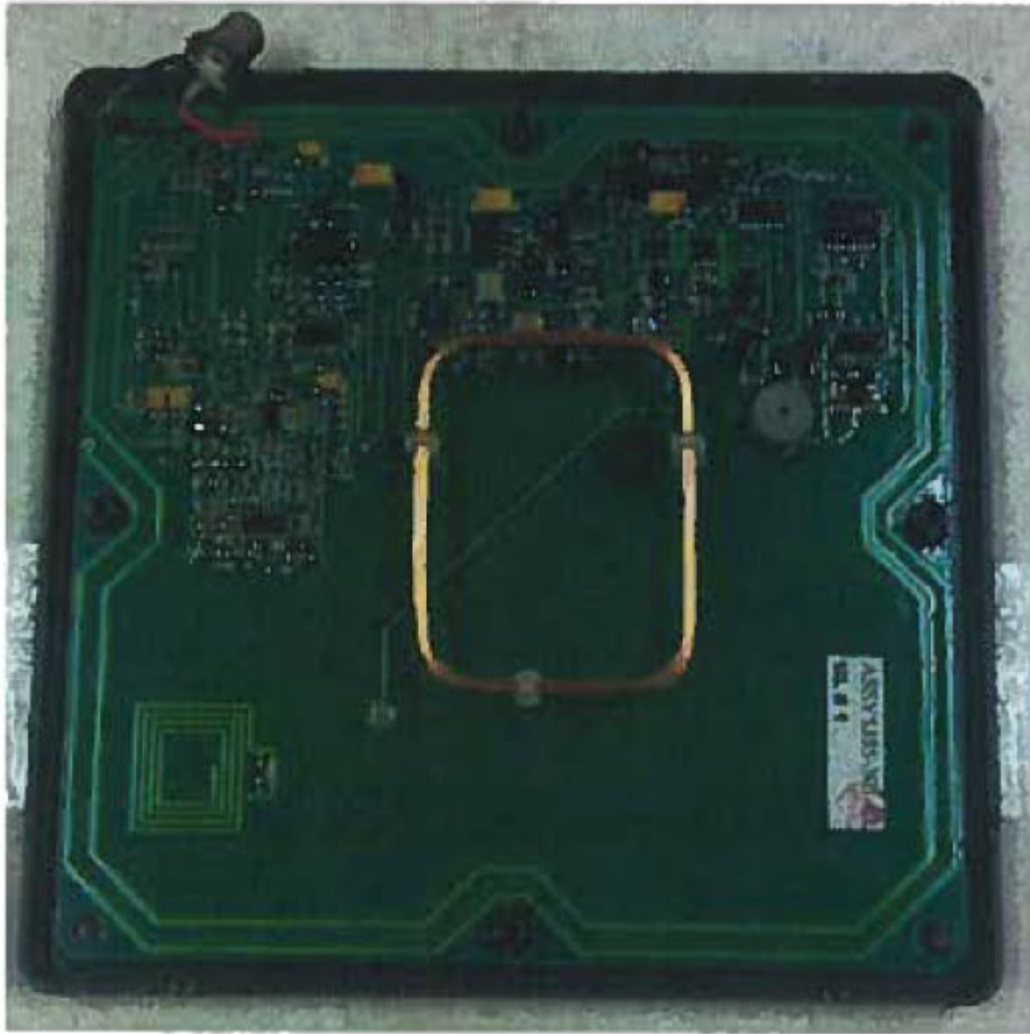
EX1008, at 16.

46. This behavior of magnetic flux can be simply modeled through the “right-hand-thumb rule.” See EX1023, at 5:15-20. The right-hand-thumb rule provides that if one points their right thumb along the direction of current flow in a wire and curls their fingers, the magnetic field curves around the wire in the direction of the curled fingers. *Id.* This also permits current direction to be determined if magnetic field lines are known. *Id.*

47. For example, it was known before the any priority date to which the ’862 patent may be entitled that it would be advantageous to provide a low-frequency loop antenna along the perimeter of a circuit board or the perimeter of a cover to the reader housing, while integrating a high frequency antenna within the

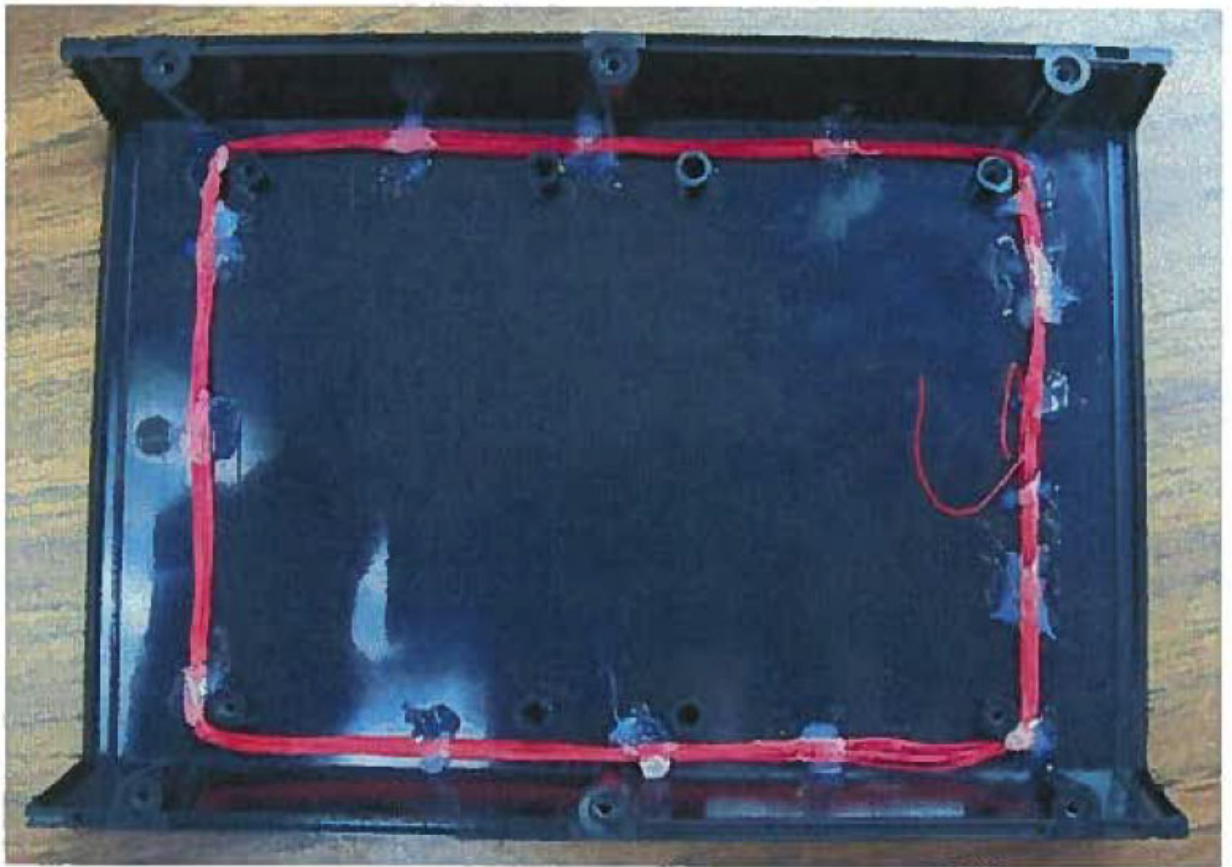
board itself. This would allow the use of a single circuit board to house the corresponding transmission and receiving electronics for both antennas, minimize the required housing of the reader, and minimize magnetic interactions between the two antennas.

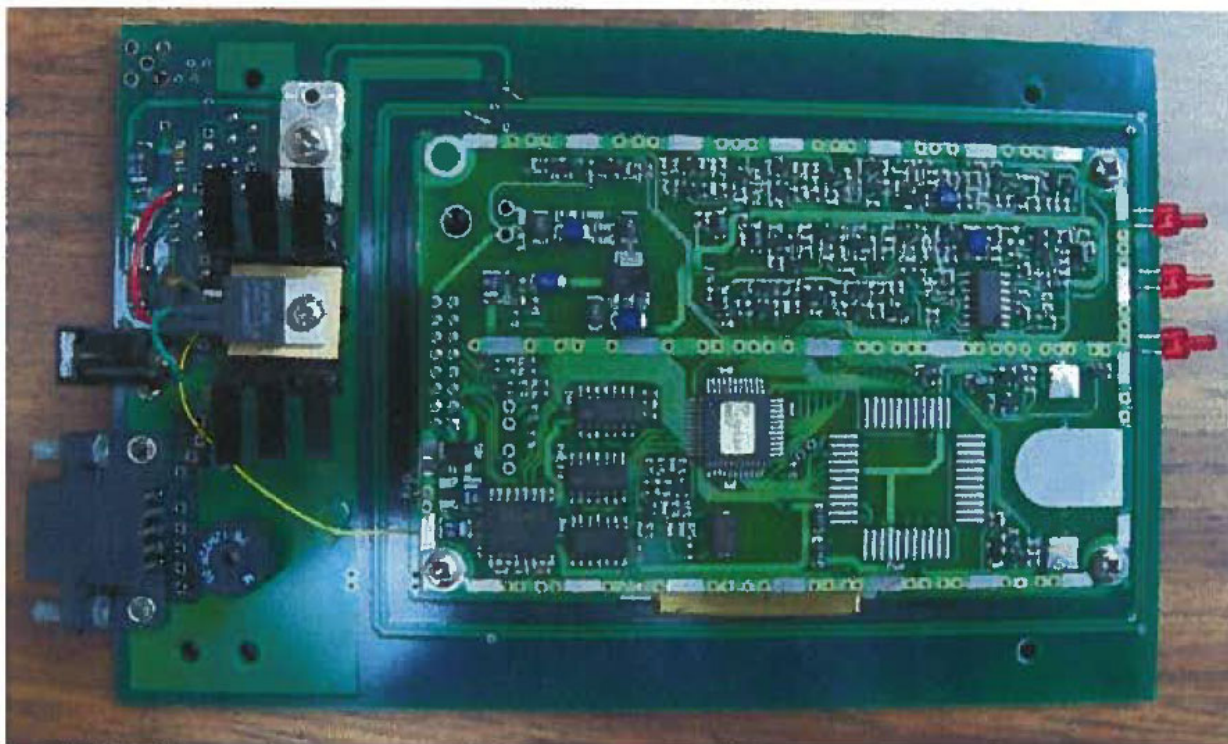
48. For example, HID's Multiprox reader—publicly available in 2003 (*compare* EX1035 with EX1036, at 59, 63, 65; *see also* EX1018, at 49-61)—contained at least two antennas. EX1018. In this configuration, the antennas are in a parallel arrangement, with one antenna embedded in the circuit board and another in a coil placed on the circuit board. In this arrangement, magnetic flux interactions are minimized due to the different sizes in the antenna loops, as the strength from the wide coil is less substantial than the central coil due to this and the spacing between the loops.



EX1018, at 50. I understand EX1018 is an expert declaration that was filed in a concluded litigation in federal district court. I have reviewed the photographs and descriptions of the products cited in that declaration that I also cite to here, and I agree based on my knowledge and skill in the art that these photographs and descriptions accurately describe these products and reflect how antennas were mounted within reader housings at the stated time.

49. As another example, the Dynansys Dual Band Evaluation Kit discloses a device containing two antennas: one within the cover housing, and another in the printed circuit board. The device is able to communicate at 13.56 MHz and 134 kHz RFID technologies. EX1017, at 2-3. In this arrangement, the antennas are arranged in parallel in a compact housing in a slightly off-set arrangement, thereby minimizing the negative interactions caused by magnetic flux.

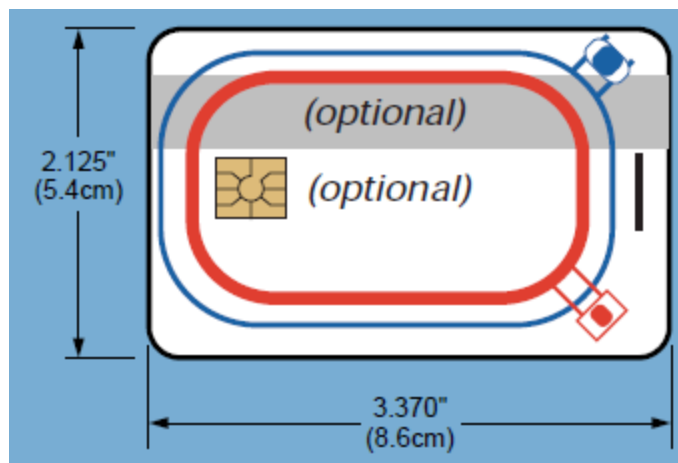




EX1018, at 37-38.

50. As another example, it was known before any priority date to which the '862 patent may be entitled that implementing a reader with two separate circuit boards—one disposed within the base of the reader housing and comprising a one antenna and associated circuitry, and one disposed within the cover of a reader housing and comprising the other antenna and associated circuitry—would provide several advantages, including allowing for simple manufacturing and separation of circuit boards for easy positioning and replacement. (*See, e.g.*, EX1006, ¶¶[0009], [0026], [0045]-[0046]; EX1007, at 2-3, 5-9, 14, 33, 41-44, 50.)

51. Further, the overlapping of antennas was well known in the prior art relating to transponders:



See EX1034, at 2 (red loop displaying 125 kHz proximity coil and the blue coil representing 13.56 MHz MIFARE coil—*see id.* at 3).

VII. THE '862 PATENT

A. Overview

52. The '862 patent “relates generally to RFID systems” and purports to be directed to an “RFID reader” with an antenna array that includes a first reader antenna tuned to operate at a first frequency and a second reader antenna tuned to operate at a second frequency. EX1001, Abstract, 1:12-16.

53. The '862 Patent recognizes that RFID systems, including RFID readers and transponders communicating information at low frequencies such as 125 kHz and at high frequencies such as 13.56 MHz, were known in the art. EX1001, at 2:1-21. For example, the '862 Patent explains that there were at least “two standard carrier frequencies which have been generally accepted for use in RFID systems”: (1) “proximity cards or proximity tags” that typically communicate at a carrier frequency “within a range of 100 to 150 kHz,” which is

“deemed low frequency”; and (2) “smart cards” that typically communicate “at a carrier frequency of 13.56 MHz, which is deemed high frequency.” *Id.*, at 2:7-18.

54. The ’862 Patent further recognizes that “[a]t present, use of RFID transponders operating at the low carrier frequency and RFID transponders operating at the high carrier frequency have proliferated throughout the world.” 1001, at 2:22-25. Thus, the ’862 patent purports to “recognize[] a need for an RFID system having one or more RFID readers, each of which is capable of communicating with a plurality of RFID transponders, one or more of which are operating at a different carrier frequency.” *Id.*, at 2:31-35.

55. The ’862 Patent further describes conventional components enabling data communication between the RFID reader, including low frequency antenna 34 and high frequency antenna 38, and associated control circuitry. *Id.*, at 1:57-59, 5:54-64; 6:21-31; 9:16-49.

56. Claim 1 of the ’862 Patent recites an RFID reader containing first and second reader antennas that are that are tuned to operate at first and second carrier frequencies, which “enabl[es] data communication” with first and second “transponder[s] transmitting data signals” at the first and second carrier frequencies, wherein “the first and second antennas are oriented along axes that are substantially parallel to one another.” EX1001, at 15:27-39. The remaining claims and limitations either further define the arrangement of the antennas, require

specific operating frequencies, require a “reader housing containing” the antennas, or recite other “conventional electronic components,” such as a signal generator. *Id.* at 6:21-31; 15:27-18:34.

B. Prosecution History

57. The ’862 patent issued on October 21, 2008 from Application No. 11/016,576 filed on December 16, 2004, which is a continuation-in-part of Application No. 10/848,246 (“the ’246 application”) filed on May 18, 2004. The December 16, 2004 continuation-in-part application added substantial new matter related to claimed antenna arrangements, including text and figures not contained in the original application, such as figures 2-6. *Compare* EX1001 *with* EX1019; *see* Priority, *infra* §VII.C; *see also* EX1022, at 63.

58. The Applicant argued during prosecution that “prior art passive transponders and readers are limited to operation at only one or the other of these two frequencies [namely, 125 kHz and 13.5 MHz] due to technical, operational and physical size constraints.” EX1003, at 214. At no point during prosecution, however, did the examiner consider or Applicant disclose any prior art describing the physical orientation of antennas within any reader. Applicant further did not disclose—and the examiner did not consider—the existence of, let alone details about, any dual- or multi-frequency RFID readers. Instead, applicant argued for “the desirability of a reader which is capable reading two different transponders,

one of which operates at a different carrier frequency than the other.” *Id.* at 214. Applicant further argued—successfully—that the prior art of record provided no motivation to use two differently tuned antennas. *Id.* at 215.

C. Priority

59. As noted, the ’862 patent issued from an application filed on December 16, 2004, which is a continuation-in-part of an earlier application filed on May 18, 2004. The references used in the grounds herein are prior art under either date. However, none of the claims of the ’862 patent are fully supported by the May 18, 2004 application.

60. Indeed, I have reviewed U.S. Patent Publication No. 2005/0258940 (the “’940 publication”) (EX1019), the publication of the May 2004-filed ’246 application, and could not identify any disclosure that teaches the specific antenna arrangements that are claimed in the ’862 patent. For example, the ’940 publication does not contain, in any form, Figures 2A and 2B, 3A and 3B, 4A and 4B, 5A and 5B, or 6A and 6B—which purport to show the embodiments of the claimed antenna arrangements of the ’862 patent. Likewise, neither the text accompanying these figures, (EX1001, at 3:60-4:12; 11:46-15:20), nor any other text describing the claimed antenna arrangements (*id.*, at Abstract, 2:62-3:21; *see also id.* at Claims 1 to 26), do not appear in the ’940 publication. *See generally* EX1019. No text or figure contained in the ’940 publication teaches the claimed antenna

arrangements, so the May 2004 application cannot provide priority support for the '862 patent.

61. Patent Owner has also claimed priority to February 12, 2004 for “at least claims 1–4, 14, and 16,” but my understanding is that Patent Owner has not provided any support for this claim. Moreover, three of the grounds explained below rely on prior art that pre-dates Patent Owner’s purported date of invention.

VIII. CLAIM INTERPRETATION

62. I understand that determining whether a claimed invention is novel and non-obvious requires comparing the prior art to the claim. I understand that claim terms are typically given their ordinary and customary meaning, as would have been understood by a POSITA. I understand that one must consider the language of the claims, the specification, and the prosecution history of record when construing claim terms.

63. I understand that, in IPR proceedings, claim terms in a patent are given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSITA”) in the context of the entire patent and the prosecution history pertaining to the patent. If the specification provides a special definition for a claim term that differs from the meaning the term would otherwise possess, the specification’s special definition controls. If a claim element is expressed as a “means” for performing a specified function, I understand that it covers the

corresponding structure described in the specification and equivalents of the described structure. I have applied these standards in preparing the opinions in this declaration. For any claim term not addressed below, I adopted the ordinary and customary meaning of the same as it would have been understood by a POSITA as of the late 2003.

64. I understand that the phrase “nominally 125 kHz” recited in claim 2 means “a carrier frequency within a range of 100 to 150 kHz,” as defined in the ’862 patent. EX1001, at 2:8-14 (“RFID systems, which employ RFID transponders of the type conventionally termed proximity cards or proximity tags, typically communicate by means of data signals at a carrier frequency within **a range of 100 to 150 kHz. This carrier frequency range is nominally referred to herein as 125 kHz carrier frequency and is deemed low frequency.**”) (emphasis added)).

IX. THE CHALLENGED CLAIMS ARE UNPATENTABLE IN LIGHT OF THE PRIOR ART IDENTIFIED IN THE PETITION

A. Ground 1: Conlin Renders Obvious Claims 1-6, 14, 16, 17, and 19-21 of the ’862 Patent

1. Conlin

65. Conlin was published on September 15, 2005, and claims priority to provisional applications filed on March 15, 2004. EX1006, Title Page. As explained further below in Section IX.A.3, I understand that Conlin is prior art to the ’862 Patent.

66. Conlin incorporates by reference Provisional Application No. 60/553,677, filed on Mar. 15, 2004 (“the ’677 application”), for all purposes. EX1006, ¶[0001].)

67. Conlin “is related to systems and methods for providing security, and in particular to systems and methods for controlled access using distributed access control system.” EX1006, at ¶¶[0002], [0005]. “Such methods include providing an access control module that is capable of operating at at least two carrier frequencies. In addition, two or more access credentials are provided that operate at one or more of the carrier frequencies. In some instances, the access control module includes a base portion and an update portion. The methods may include modifying the functionality of the access control module by replacing the update portion with another update portion.” *Id.* ¶[0006].

68. For example, Fig. 3 shows “an access control grouping 300 in accordance with one or more embodiments of the present invention.” *Id.*, ¶[0030]. “Grouping 300 includes an access control module 310 capable of querying various credentials 350, 360 at different carrier frequencies. In operation, a credential 350 transmits information to access control module 310. This information is received at a receiver that is determines the carrier frequency at which credential 350 is transmitting. In this case, it is a carrier frequency associated with a channel A320 of access control module 310.” *Id.*

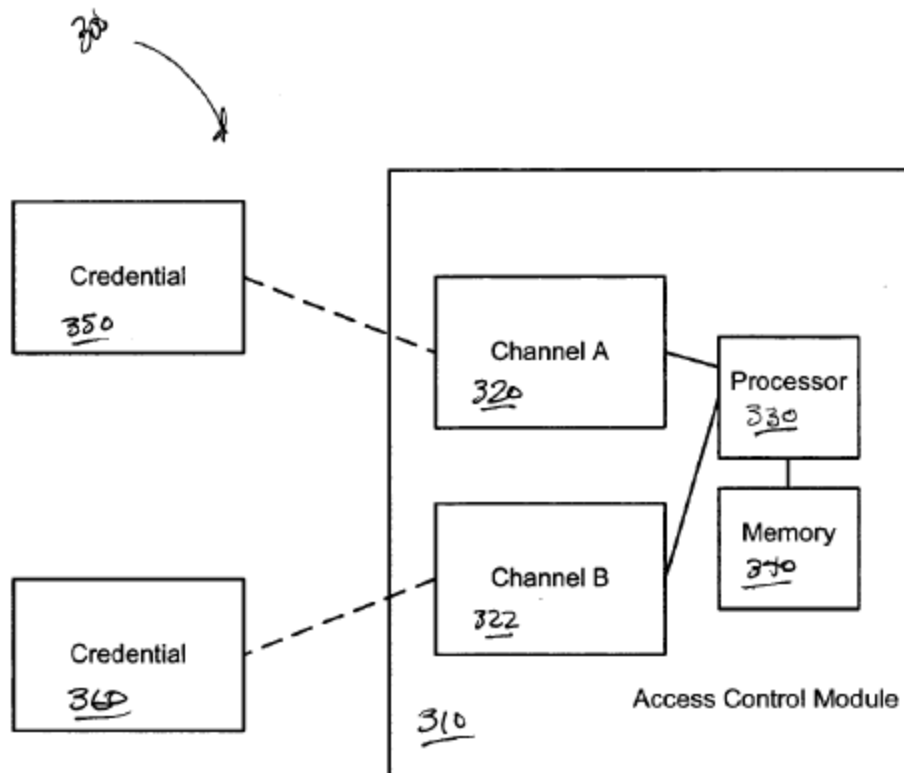


Fig. 3

69. Conlin teaches that the methods disclosed may “effectuate a credential migration. This credential migration may include replacing one provided access credential with another access credential. In one particular embodiment of the present invention, a control reader in accordance with one or more embodiments of the present invention operates at two distinct carrier frequencies, 125 KHZ and 13.56 MHz. This multiple frequency approach may, among other things, provide for transitioning systems from one generation of control to another. Thus, as an

example, where access control is initially provided at 125 KHZ, new processes of access control can be supported at 13.56 MHz until the new processes of access control are fully implemented and the 125 KHZ processes can then be ended.” *Id.* ¶[0026].

70. Fig. 6 of Conlin illustrates “a modular access control device 600 in accordance with one or more embodiments of the present invention.” *Id.* ¶[0045] *see also id.* ¶[0020]. The control device 600 “facilitates a simple method for updating the functionality by replacing an existing update module with another update module,” (*id.* ¶[0046]), which enables “transitioning systems from one generation of control to another,” such as between systems that operate at 125 kHz and 13.56 MHz, (*see id.* ¶[0026]). Conlin teaches that in various embodiments, the update module may include any of a processor, computer readable medium, a “selector contact that elects between software already loaded in a computer readable medium associated with base module 610,” and a PCB. *Id.* ¶[0046.] Further, “it is also possible to include antennas, tuning networks, and appropriate RF reader electronics for other frequency reader systems including but not limited to 125 KHZ, 433 MHz, 800 MHz, 900 MHz and/or 2400 MHz.” *Id.*

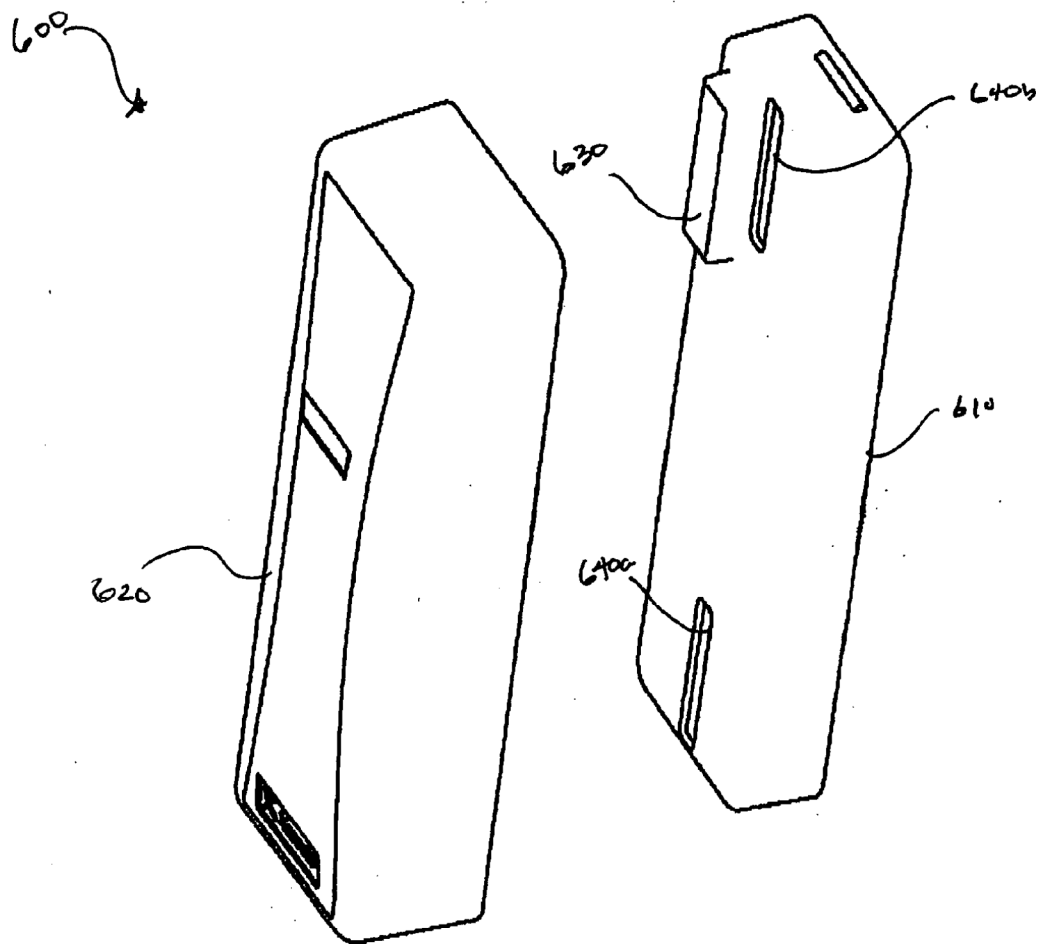


FIG. 6

71. Conlin is in the same field as the '862 patent because Conlin relates to RFID systems for access control. (EX1006 at Abstract, ¶¶[0005]-[0012].) Conlin is pertinent to the problems the '862 patent purportedly addresses because Conlin is directed to an RFID reader capable of communicating at both high and low

frequencies, and the arrangement of antennas and circuitry within such a reader.

(*Id.* at ¶¶[0023]-[0057].) Conlin is therefore analogous art to the '862 patent.

2. The '677 Provisional Application

72. Conlin incorporates the '677 application by reference for all purposes. EX1006, ¶[0001].

73. The '677 application “relates generally to access control readers and more specifically to modular contactless smart card access control readers.”

EX1007 at 2. The disclosed “system includes functionality at both 125 KHz and 13.56 MHz.” *Id.* at 7. In particular, the '677 application discloses “a modular contactless smart card access control reader, which comprises [a] base assembly, a cover assembly and a communication adaptor.” *Id.* at 6. In one embodiment, “the base reader board contains the antenna for one frequency,” and “the snap-on cover contains the antenna for the other frequency”:

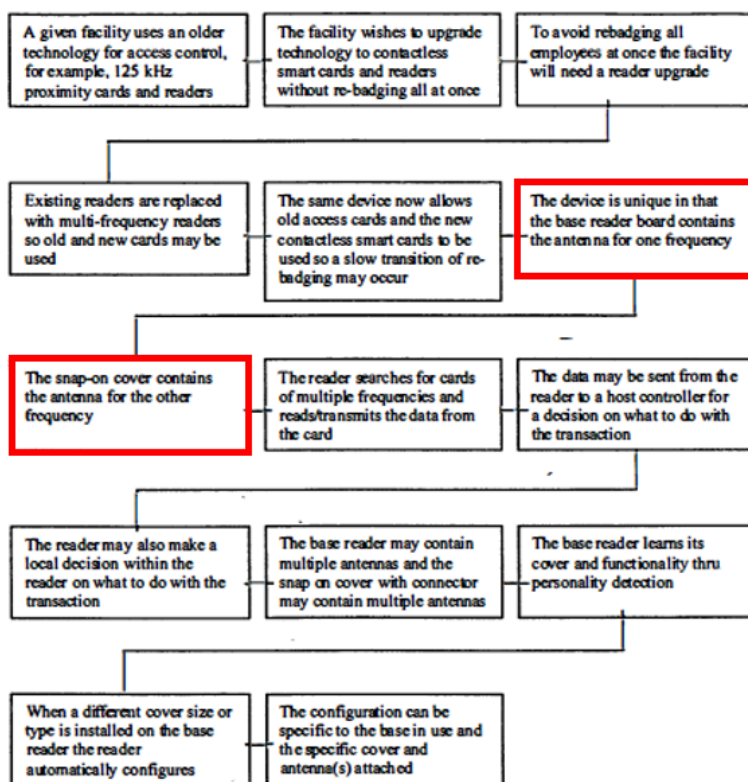
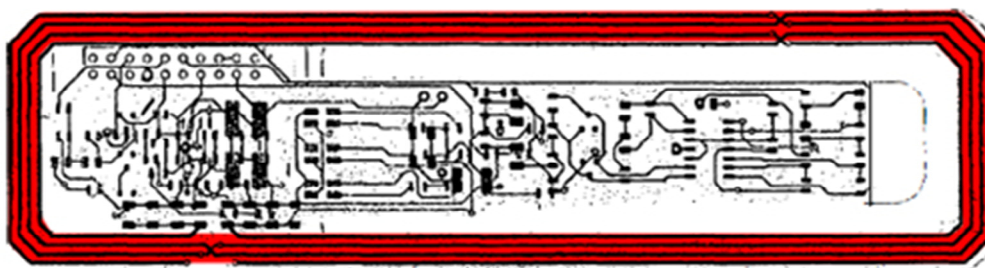


FIG. 10 illustrates yet another method in accordance with some embodiments of the present invention.

Id. at 14 (annotated.); *see also id.* at 42. At least one antenna of the system described in the '677 application is printed on the circuit board:



Id. at 36 (annotated).

74. The '677 application is in the same field as the '862 patent because the '677 application relates to RFID systems used for access control. (EX1007 at 2.) The '677 application is pertinent to the problems the '862 patent purportedly addresses because the '677 application is directed to an RFID reader capable of communicating at both high and low frequencies, and the arrangement of antennas and circuitry within such a reader. (*Id.* at 6-8, 14.) The '677 application therefore is analogous art to the '862 patent.

3. The '677 Application Provides Support for At Least One Claim in Conlin

75. My understanding is that in order for a patent publication to be considered prior art as of the filing date of the provisional application to which it claims priority, at least one claim contained in the publication must be supported by disclosure contained in the provisional application.

76. It is my opinion that the '677 application provides support for at least one claim in Conlin. For example, Claim 12 in Conlin is supported by the '677 application, as explained below.

a. Claim 12[pre]: “An access control device, the access control device comprising:”

77. The '677 Application supports [12pre] with its disclosures of an access control device. *See, e.g.* EX1007, at 1 (“The present invention relates generally to access control readers and more specifically to modular contactless

smart card access control readers. Such modular readers can provide for cost-effective, scalable and/or easily configurable design for a physical access control reader.”), *id.* at 2 (“Existing access control readers are limited in functionality. Such readers typically include a unified electronics board, a mounting plate, and an aesthetically pleasing cover.”).

b. [12A] “an access control module, wherein the access control module includes a base portion and an update portion”

78. The ’677 Application discloses an access control module, including a base portion and an update (e.g., cover) portion. *See, e.g.*, Ex. 1007, at 4 (“In some embodiments of the present inventions a potted design is provided that includes two or more components. Such components can include a first electronic circuit board and a second electronic circuit board. The access control can be designed such that the first electronic circuit board and the second electronic circuit board are attached together by a connector. The first electronic circuit board provides baseline functionality, and the second electronic circuit board provides modular functionality. Thus, when a system is to be upgraded, the second electronic circuit board can be removed from the first electronic circuit board, and replaced by a different electronic circuit board. This provides an ability to upgrade a system without requiring a rewiring and/or total replacement of the system. In some cases, the system does not need to be dismounted from its fixed location, rather, only the

upgrade component needs to be added. One example of the second electronic circuit board is that associated with a keypad controller and that associated with a RF controller.”); *id.* at 4 (describing “base assembly” and “cover assembly” for access control reader); *id.* at 13, Fig. 8 (disclosing steps for installing reader base and cover).

c. [12B] “wherein the update portion is electrically coupled to the base portion via a detachable electrical connector,”

79. The ’677 Application discloses that the update portion is electrically coupled to the base portion via a detachable electrical connector. EX1007, at 4 (“The access control can be designed such that the first electronic circuit board and the second electronic circuit board are attached together by a connector. The first electronic circuit board provides baseline functionality, and the second electronic circuit board provides modular functionality. Thus, when a system is to be upgraded, the second electronic circuit board can be removed from the first electronic circuit board, and replaced by a different electronic circuit board. This provides an ability to upgrade a system without requiring a rewiring and/or total replacement of the system.”); *id.* at 7 (describing the interconnection of components and sub-components by stating that “the back of the cover assembly is potted with a rectangular shaped cavity recessed into the potting. In this cavity, there is a mating female PCB interconnect header. The cover assembly is snapped

onto the base assembly and during this process, the female connector in the cover assembly engages the male connector in the base assembly. This connector mating provides the interconnect of all of the circuits that are distributed between the base and cover assemblies.”).

d. [12C] “wherein operation of the access control module is based at least in part on an interaction between the base portion and the update portion.”

80. The '677 application discloses that operation of the access control module is based at least in part on an interaction between the base portion and the update portion. EX1007, at 6 (disclosing functionality of the base assembly PCB and cover assembly and “a personality detection circuit that allows the [microcontroller] in the base assembly to determine the exact configuration of the cover assembly plugged into it”); *id.* at 7 (disclosing that the operations enabled by the interconnection of base portion and update portion “include but are not limited to configuration or reader behavior, loading keys to the reader, addressing the reader for an RS-485 bus, downloading data from the reader and flashing the reader with new firmware”); *id.* at 8-9 (“The inventive device includes a base assembly, a cover assembly and a communication adaptor. The base assembly consists of a pcb potted into a piece of plastic which contains the following functionality: (1) the contactless smart card communications engine and security functions, (2) all reader to host controller interface circuitry and (3) the reader

[microcontroller] and all associated functionality. The cover assembly consists of a pcb ported into a piece of plastic which contains the following functionality: (1) One or more antennas and associated tuning circuits, (2) additional analog front end circuitry, (3) leds and (4) a part of the personality detection scheme novel in this invention. The communications adaptor consists of a small pcb ported in a piece of plastic that contains the following functionality: (1) An infrared interface, (2) several momentary switches and (3) the circuitry necessary to program a microcontroller in the base assembly.”).

4. Claim 1

a. 1[pre]: “An antenna array for an RFID reader comprising:”

81. To the extent the preamble is limiting, Conlin discloses this limitation. For example, Conlin discloses an RFID reader that may contain multiple antennas operating at distinct frequencies. EX1006, ¶¶[0026], [0046]; EX1007, at 1, 5-7, 14, 33.

b. 1[A]: “a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency”

82. Conlin discloses this limitation. For example, Conlin “describes various systems and methods for access control. One such method includes providing an access control module that is capable of operating at least a first

carrier frequency and a second carrier frequency. In addition, the method includes providing a first access credential that operates at the first carrier frequency, and providing a second access credential that operates at the second carrier frequency.” EX1006, at Abstract; EX1007, at 5.

83. Conlin teaches that one way of implementing a multi-frequency system is to provide an “access control module [that] includes a base portion and an update portion. The update portions is tailored for operation with a particular credential, and the methods further comprise replacing the update portion with another update portion that is tailored for operation with a replacement credential.” EX1006, ¶[0009]; *see also* EX1006, ¶[0045]; EX1007, 2-3, 5-10, 14, 33, 41. The base portion 610 and update portion 620 are shown in Figure 6:

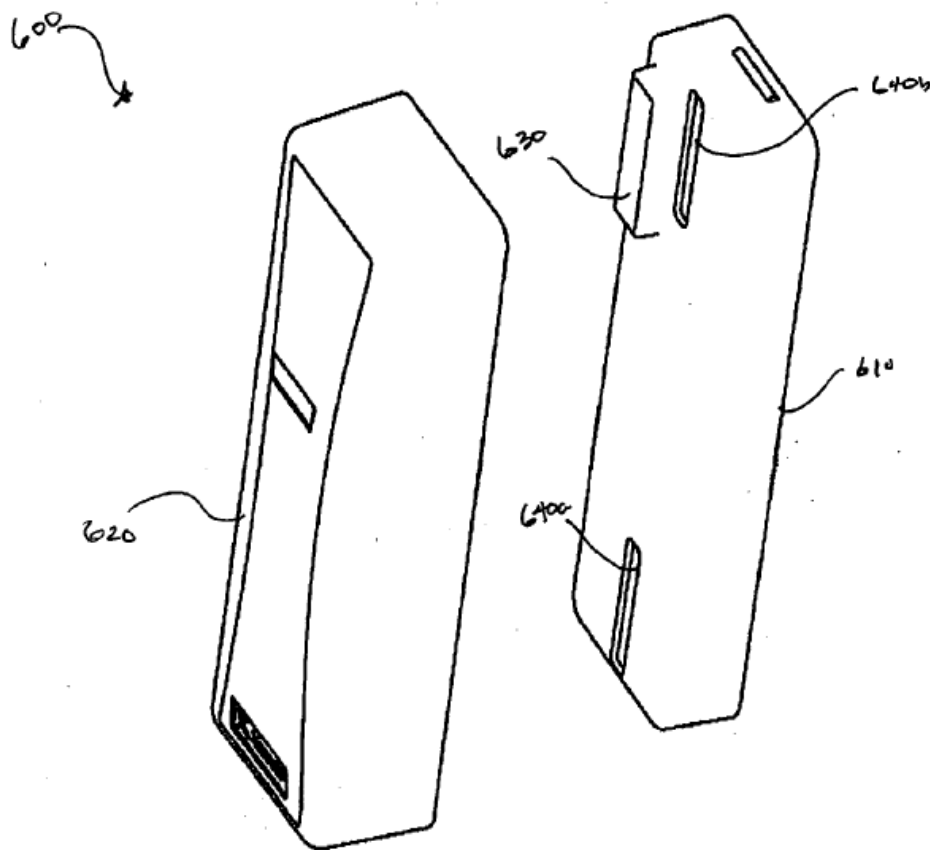


FIG. 6

See also EX1007, at 10; 37.

84. Conlin teaches that a number of frequencies may be used with the base and update portions, including 125 kHz, 13.56 MHz, 433 MHz, 800 MHz, 900 MHz and/or 2400 MHz. EX1006, ¶¶[0026], [0046]; EX1007, at 5, 7, 33, 41-42, 50. For example, Conlin teaches a reader that operates at two frequencies—125 kHz (a low carrier frequency) and 13.56 MHz—to “transition

systems from one generation of control to the other.” EX1006, ¶[0026]; EX1007, 5, 7.

85. A POSITA would have understood from Conlin’s disclosures that it would be advantageous to dispose the 125 kHz antenna in the update portion—i.e., the cover housing—which could be removed after “transitioning systems from one generation of control to another” until “the 125 KHZ processes can ... be ended.” EX1006, ¶[0026]; *see also id.* at ¶[0046]; EX1007, 5, 7.

86. Conlin further discloses this limitation through the incorporation by reference of the ’677 application.

87. The ’677 application, incorporated by reference into Conlin, teaches an access control device that can operate at multiple frequencies. EX1007, at 2-3, 5, 6, 7, 14 [Fig. 10.], 33, 41, 50. One of the frequencies may be 125 kHz. *Id.* at 5, 6, 7, 14, 33, 41, 50.

88. The ’677 application discloses that the multiple frequencies may be implemented through separate circuit boards housed in a “base assembly” and a “cover assembly.” EX1007, at 6, *see also id.* at 2 (“In some embodiments of the present inventions a potted design is provided that includes two or more components. Such components can include a first electronic circuit board and a second electronic circuit board. The access control can be designed such that the first electronic circuit board and the second electronic circuit board are attached

together by a connector. The first electronic circuit board provides baseline functionality, and the second electronic circuit board provides modular functionality. Thus, when a system is to be upgraded, the second electronic circuit board can be removed from the first electronic circuit board, and replaced by a different electronic circuit board. This provides an ability to upgrade a system without requiring a rewiring and/or total replacement of the system. In some cases, the system does not need to be dismounted from its fixed location, rather, only the upgrade component needs to be added.”); EX1007, 5, 6-7, 8-10, 14, 33, 41.

89. A POSITA would have understood that the '677 application also teaches that it would be advantageous to dispose the 125 kHz reader antenna within the cover housing when migrating from 125 kHz access control systems to 13.56 MHz systems. *See* EX1007, at 5-7, 14, 33, 41-42.

90. The '677 application also discloses an “Antenna Board,” that is contained in the “Snap-on covers”:

Reader Design Concept - Cover

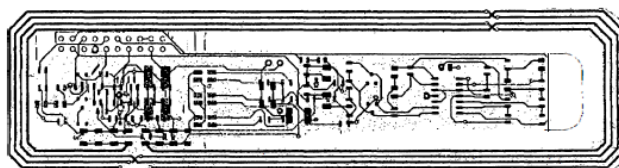


- ◆ Snap-on covers containing “Antenna Board”:
 - 13.56 MHz antenna & tuning components
 - 125 KHz analog front end
 - LED’s (red, green & amber capability)
 - Tamper detection scheme
 - Keypad electronics
 - LCD ???
 - Personality detection
 - 2 Unused I/O (RFU)
 - Programming Interfaces:
 - Immediate hardware programming capability
 - Future Infrared “communication adapter” programming capability

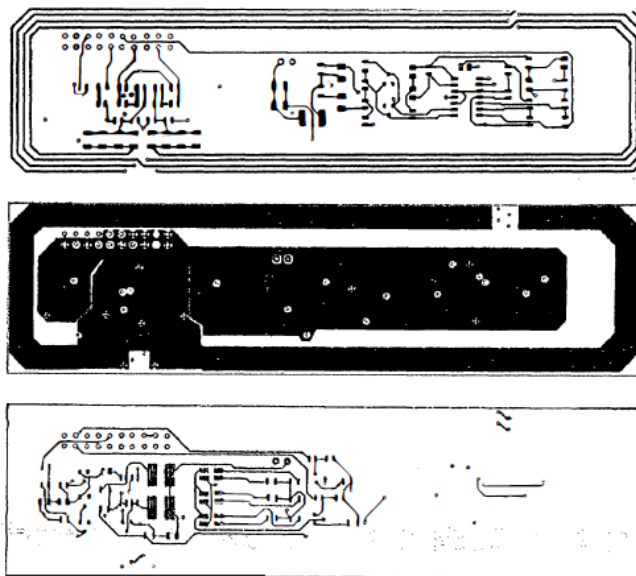
EX1007, at 42; *see also id.* at 5, 7-9, 14, 41, 43-44.

91. The '677 application discloses a circuit board, consisting of multiple layers, for the antenna board:

Antenna Board Layout



Antenna Board Layout



EX1007, at 43-44.

92. Although the '677 application does not indicate exactly which frequency this antenna board is for, it would have been obvious to a POSITA to use this antenna board for 125 kHz. For example, a POSITA would have recognized the antenna disposed around the perimeter of the circuit board shown at the top to be indicative of a low-frequency antenna due to the relatively long windings.

93. Further, implementing the antennas disclosed on the circuit boards to transmit at 125 kHz would have been a routine and conventional step to a POSITA before the priority date. A POSITA would have taken several classes in circuit design, including in radio-frequency circuit design. Further, a POSITA would have

been able to design, test, and adjust the placement of various electrical components as needed in the combined reader through the circuit board and antenna modeling and simulation programs available at the time, as well as through physical prototypes. A POSITA would have known that the ability of a system to receive signals at a given frequency is a mathematical function of antenna length, number of windings, width of the antenna wire, the capacitance attached to the antenna, and the magnetic field strength through the antenna. *See* EX1025, at 6. A POSITA would have recognized that the disclosed circuit board could be used with any frequency, such as 125 kHz, so long as an appropriate capacitance is connected to the antenna. Moreover, with the disclosure of an antenna board for a 125 kHz antenna or a 13.56 MHz antenna (EX1007, at 42), it would be obvious to set the antenna on the disclosed antenna board to operate at either of these frequencies, including 125 kHz. Indeed, multi-turn loop antennas placed along the perimeter of a circuit board, like the one shown above, are characteristic of both 125 kHz and 13.56 MHz antenna designs around late 2003.

94. The '677 application further discloses an RFID reader that “searches for cards of multiple frequencies and reads/transmits the data from the card.” EX1007, at 14; *see also id.* at 8.

95. Therefore, Conlin, through the incorporated '677 application, teaches “a first reader antenna tuned to operate at a first low carrier frequency enabling

data communication with a first transponder transmitting data signals at said first low carrier frequency.”

- c. **1[B]: “and a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency”**

96. Conlin discloses this limitation. For example, Conlin “describes various systems and methods for access control. One such method includes providing an access control module that is capable of operating at least a first carrier frequency and a second carrier frequency. In addition, the method includes providing a first access credential that operates at the first carrier frequency, and providing a second access credential that operates at the second carrier frequency.” EX1006, at Abstract; EX1007, at 5.

97. Conlin teaches that one way of implementing a multi-frequency system is to provide an “access control module [that] includes a base portion and an update portion. The update portions is tailored for operation with a particular credential, and the methods further comprise replacing the update portion with another update portion that is tailored for operation with a replacement credential.” EX1006, ¶[0009]; *see also id.* ¶[0045]; EX1007, 2-3, 5-10, 14, 33, 41.

98. Conlin discloses that one of the two frequencies used to communicate with credential transponders may be 13.56 MHz. *See* EX1006 ¶[0026] (“In one

particular embodiment of the present invention, a control reader in accordance with one or more embodiments of the present invention operates at two distinct carrier frequencies, 125 KHZ and 13.56 MHz. This multiple frequency approach may, among other things, provide for transitioning systems from one generation of control to another. Thus, as an example, where access control is initially provided at 125 KHZ, new processes of access control can be supported at 13.56 MHz until the new processes of access control are fully implemented and the 125 KHZ processes can then be ended.”); EX100, at 5.

99. Conlin further discloses this limitation through the incorporation by reference of the ’677 application.

100. The ’677 application, incorporated by reference into Conlin, teaches an access control device that can operate at multiple frequencies. EX1007, at 2-3, 5, 6, 7, 14 [Fig. 10.], 33, 41, 50. One of the frequencies may be 13.56 kHz. *Id.* at 5, 7, 33, 42, 50; *see also id.* at 15-18.

101. The ’677 application discloses that the multiple frequencies may be implemented through separate circuit boards housed in a “base assembly” and a “cover assembly.” EX1007, at 6, *see also id.* at 2 (“In some embodiments of the present inventions a potted design is provided that includes two or more components. Such components can include a first electronic circuit board and a second electronic circuit board. The access control can be designed such that the

first electronic circuit board and the second electronic circuit board are attached together by a connector. The first electronic circuit board provides baseline functionality, and the second electronic circuit board provides modular functionality. Thus, when a system is to be upgraded, the second electronic circuit board can be removed from the first electronic circuit board, and replaced by a different electronic circuit board. This provides an ability to upgrade a system without requiring a rewiring and/or total replacement of the system. In some cases, the system does not need to be dismantled from its fixed location, rather, only the upgrade component needs to be added.”); EX1007, at 5, 6-7, 8-9, 14 [Fig. 10], 33, 41.

102. A POSITA would have understood from Conlin and the incorporated '677 application's disclosures that it would be advantageous to dispose the 125 antenna in the cover housing and the 13.56 MHz antenna in the base portion. For example, the base portion is anchored to a wall, representing a more permanent installation. *See* EX1006, ¶[0054] (“First, the base assembly is wired into the existing building wiring at the reader installation location and the base assembly is mounted to the wall or mullion using screws.”); EX1007, at 5-7, 13 [Figs. 8, 9]. In order to “transition[] systems from one generation of control to another” (EX1006, ¶[0026]; EX1007, at 5) it is intuitive to place the system of the next generation as the permanent installation, and place the legacy system in the

cover. Indeed, it would have been obvious to place the legacy 125 kHz system in the cover portion because once “125KHz processes can [] be ended,” the cover containing the obsolete electronics could simply be removed and the base would continue operation at 13.56 MHz. EX1006, ¶[0026]; EX1007, at 5.

103. The '677 application further discloses an “Antenna Board,” including a “13.56 MHz antenna design”:



Antenna Board Status

- ◆ Antenna Board Layout Complete including:
 - 125 KHz Analog Front End circuit mock-up:
 - Exciter breadboard built and tested
 - Receiver breadboard built and tested
 - Hand made antenna built and tested
 - Antenna designed and first prototypes built
 - 13.56 MHz antenna design and tuning network

EX1007 at 42; *see also id.* at 5, 7 9, 14, 41.

Reader Design Concept - Cover



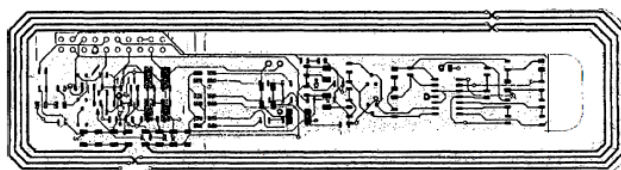
♦ Snap-on covers containing “Antenna Board”:

- 13.56 MHz antenna & tuning components
- 125 KHz analog front end
- LED’s (red, green & amber capability)
- Tamper detection scheme
- Keypad electronics
- LCD ???
- Personality detection
- 2 Unused I/O (RFU)
- Programming Interfaces:
 - Immediate hardware programming capability
 - Future Infrared “communication adapter” programming capability

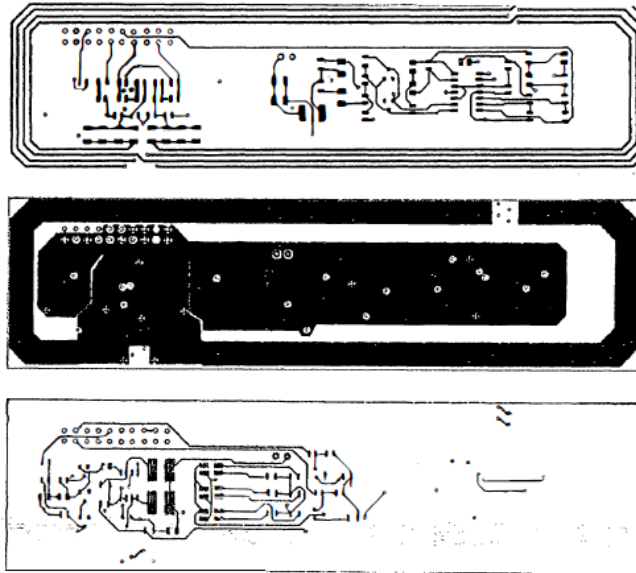
EX1007, at 41; *see also id.* at 5, 7 9, 14, 41.

104. The '677 application discloses a circuit board, consisting of multiple layers, for the antenna board:

Antenna Board Layout



Antenna Board Layout



EX1007, at 43-44.

105. A POSITA would have known that one or more of the disclosed circuit boards should be implemented with a 13.56 MHz antenna and associated circuitry. Such an implementation would have been a routine customization of an antenna board, involving conventional antenna and circuitry components, and well within the knowledge and skill of a POSITA before 2004. Indeed, a POSITA would have taken several classes in circuit design, including in radio-frequency circuit design. Further, a POSITA would have been able to design, test, and adjust the placement of various electrical components as needed in the combined reader through the circuit board and antenna modeling and simulation programs available at the time, as well as through physical prototypes.

106. A POSITA would have known that the ability of a system to receive signals at a given frequency is a mathematical function of antenna length, number of windings, width of the antenna wire, the capacitance attached to the antenna, and the magnetic field strength through the antenna. EX1025, at 6. A POSITA would have recognized that the disclosed circuit board could be used with any frequency, such as 13.56 MHz, so long as an appropriate capacitance is connected to the antenna. Moreover, with the disclosure of an antenna board for a 125 kHz antenna or a 13.56 MHz antenna (EX1007, at 42), it would be obvious to try setting the antenna on the disclosed antenna board to operate at either of these frequencies, including 13.56 MHz. Moreover, multi-turn loop antennas placed along the perimeter of a circuit board, like the one shown above, are characteristic of both 125 kHz and 13.56 MHz antenna designs around late 2003.

107. The '677 application further discloses an RFID reader that “searches for cards of multiple frequencies and reads/transmits the data from the card.” EX1007, at 14; *see also id.* at 8.

108. Therefore, Conlin, through the incorporated '677 application, teaches “a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency.”

- d. 1[C]: “wherein the first and second antennas are oriented along axes that are substantially parallel to one another.”

109. Conlin discloses this limitation. Figure 6 of Conlin shows the base portion 610, and the update portion (snap-on cover) 620:

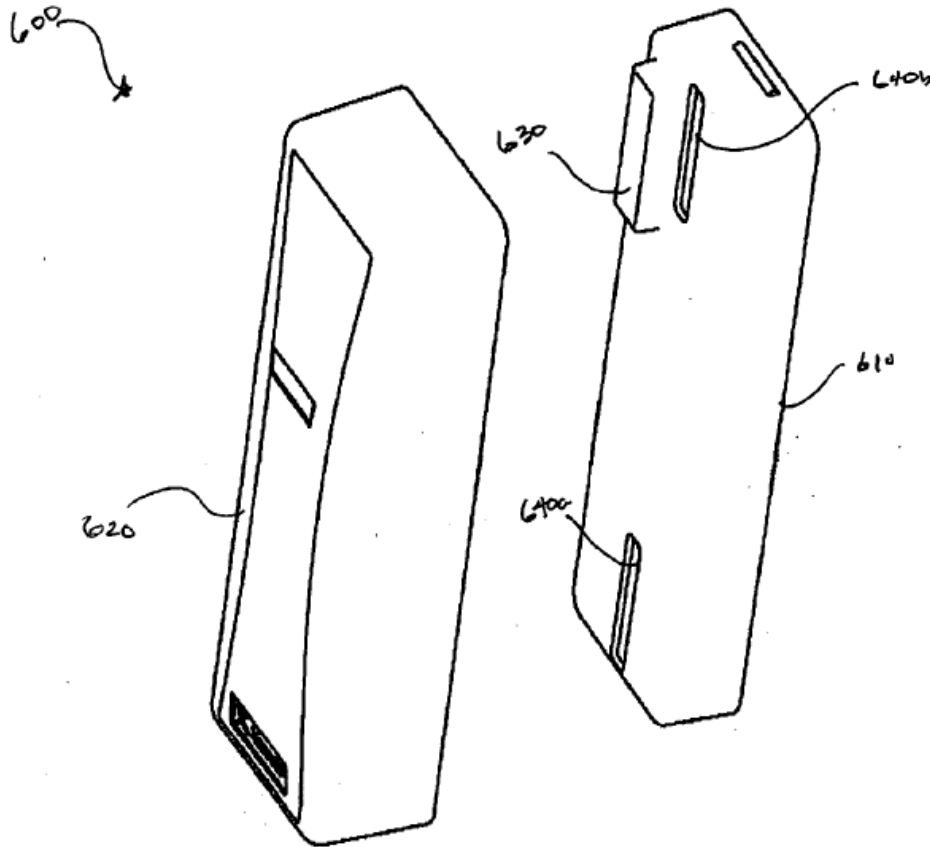


FIG. 6

EX1006, Fig. 6; see also EX1007, at 10, 37-39, 45.

110. The incorporated-by-reference '677 application discloses that the “base reader board contains the antenna for one frequency” and the “snap-on cover contains the antenna for the other frequency.”

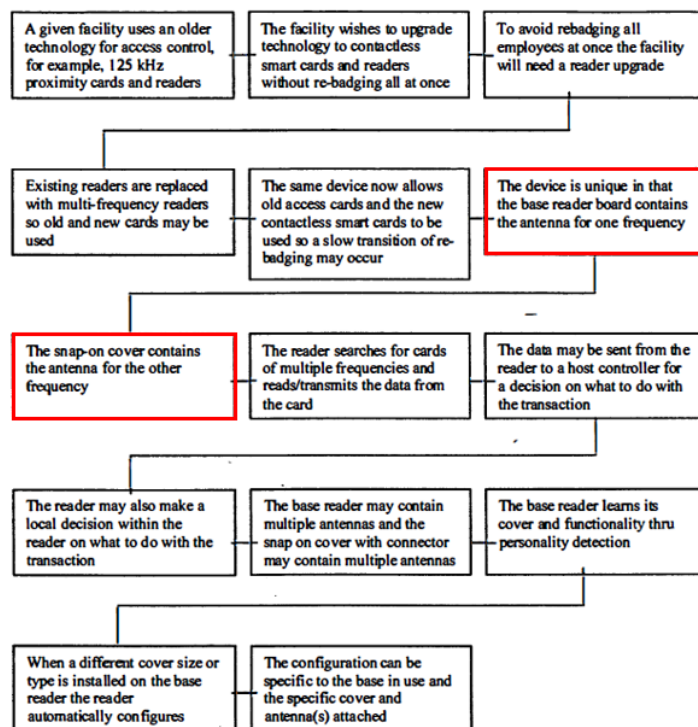
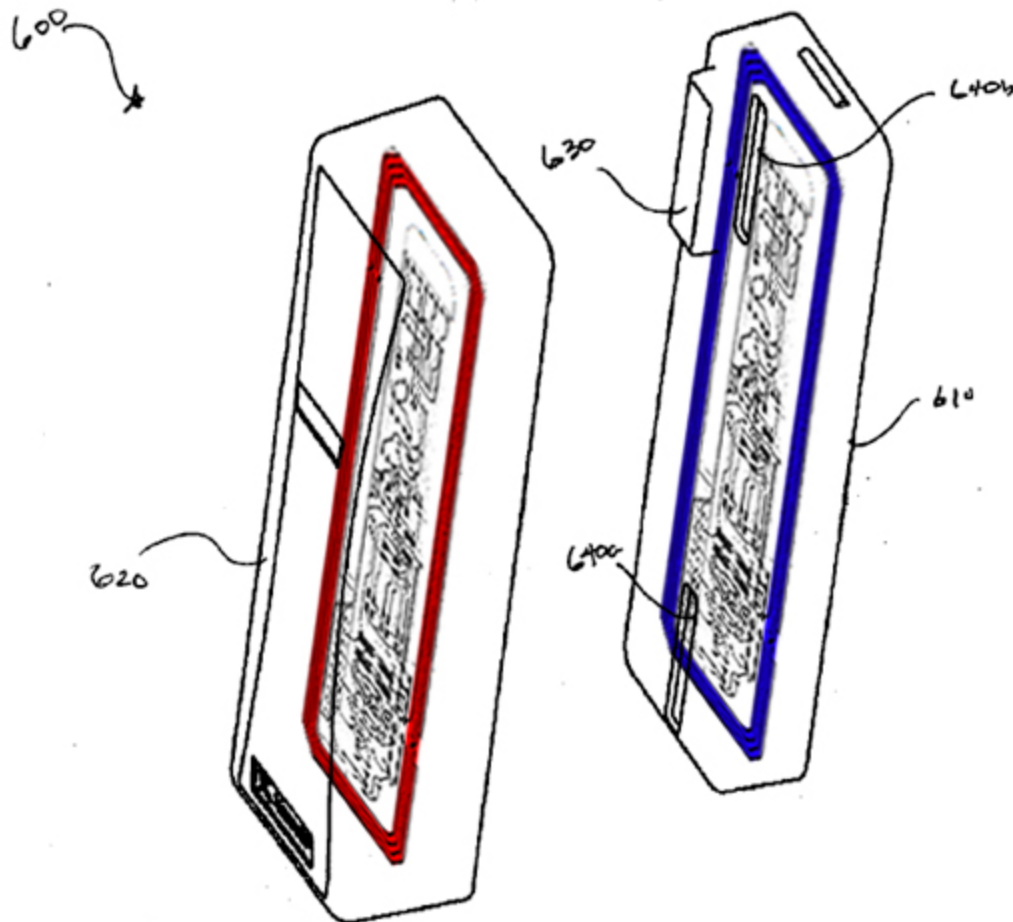


FIG. 10 illustrates yet another method in accordance with some embodiments of the present invention.

EX1007, at 14; *see also id.* at 9-10, 37-40, 45. As described in Claims 1[A] and 1[B], it would be obvious to place the 125 kHz antenna in the cover, and the 13.56 MHz antenna in the base portion. *Supra*, §§IX.A.4.b, c.

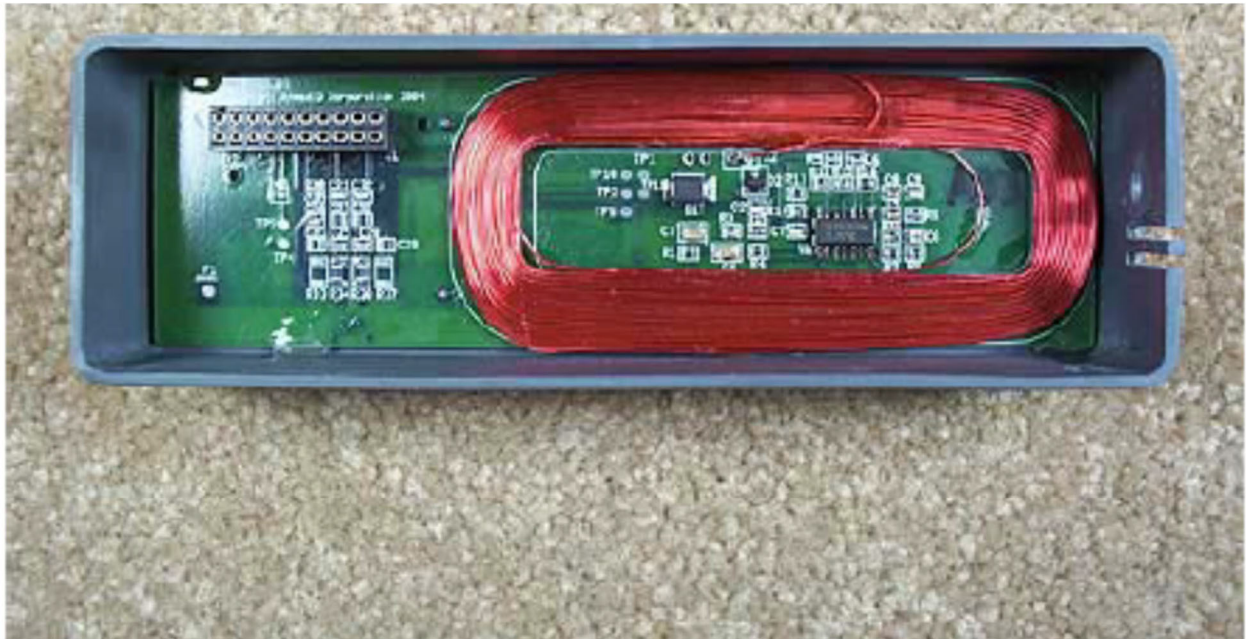
111. A POSITA would have understood that in this configuration, the antenna on the flat circuit board in the base of the reader would be oriented along an axis that is substantially parallel to the axis of the other antenna provided on the flat circuit board in the update portion (snap-on cover). Annotated Figure 6 shows

the 125 kHz reader antenna (**red**) in the update portion 620 and the 13.56 MHz antenna (**blue**) in the base portion 610, as described in Claims 1[A] and 1[B], *supra* §§IX.A.4.a, b.

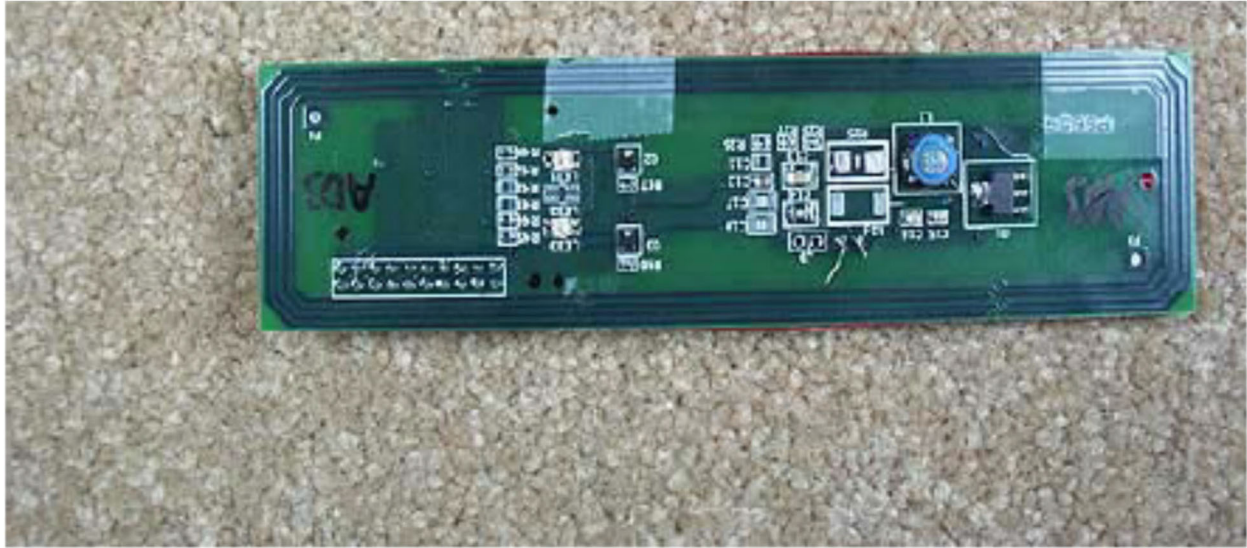


112. A POSITA would have known that the 125 kHz antenna and the 13.56 MHz antenna disclosed in Conlin could also be implemented on either side of a single circuit board. For example, I understand that the original assignee of Conlin, XceedID, released a commercial embodiment of Conlin, known as the XF1100 Reader. *See* EX1028; EX1031, at 49-56, 63-66; EX1022, at 88

(“Plaintiffs [Patent Owner] admit that XF1100 grant of equipment authorization from the FCC is dated October 19, 2004.”) This particular commercial embodiment shows a reader with a printed circuit board with two antennas, one disposed on either side of the circuit board and that is placed in one portion of the reader housing (*See* EX1006, ¶¶[0026], [0046]; EX1007, at 6, 7 14, 41-42), as shown below in a 2004 submission to the Federal Communications Commission (FCC):



Antenna PCB Top



Antenna PCB Bottom

EX1027, at 3-4.

113. Thus, whether the two antennas were disposed on either side of a single circuit board or separately in the reader base and cover, as disclosed and suggested by Conlin, a POSITA would have known that it would be advantageous to dispose the antennas such that they would be oriented along axes that are substantially parallel to each other. Indeed a POSITA would have known that such orientation would have provided multiple advantages, including allowing for a compact assembly and housing, minimizing magnetic flux, and ensuring strong signal strength. *Supra*, §VI.C.

5. Claim 2: “The antenna array of claim 1, wherein said first low carrier frequency is nominally 125 kHz.”

114. See Claim 1[A], *supra* §IX.A.4.b.

6. **Claim 3: “The antenna array of claim 2, wherein said second high carrier frequency is about 13.56 MHz.”**

115. See Claim 1[B], *supra* §IX.A.4.c.

7. **Claim 4: “The antenna array of claim 1, further comprising a reader housing containing said first and second antennas.”**

116. Conlin discloses this limitation. Conlin discloses a “base portion 610” and an “update portion 610,” as shown in Fig. 6”:

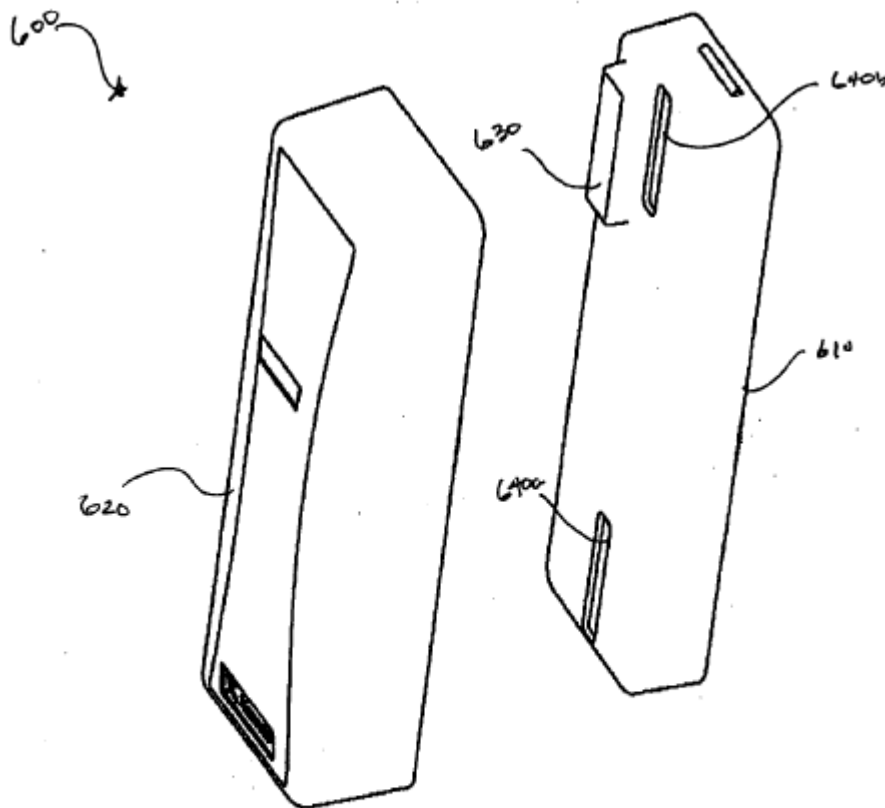


FIG. 6

See EX1006, Fig. 6, ¶[0045]; *see also id.* ¶[0054] (describing the installation procedure of the base and cover portions; EX1007, at 10, 37-39, 45.

117. The incorporated-by-reference '677 application also discloses this claim by teaching the use of a “base assembly” and “a cover assembly.” EX1007, at 3. Figures 1 and 2 display the base and cover assemblies:



FIG. 1 is a perspective view of the base assembly in accordance with an embodiment of the present invention.



FIG.2 is a perspective view of the cover assembly in accordance with an embodiment of the present invention.

EX1007 at 7, 9-10, Figs. 1, 2; *see also id.* at 37-38, 41. The base and update portions of Conlin, and cover and base assemblies of the '677 application, form the reader housing. As described in claim 1[C], *supra* §IX.A.4.d, Conlin discloses that the base and cover assemblies contain the antennas.

8. Claim 5

- a. **5[pre]: “An antenna array for an RFID reader comprising:”**

118. See Claim 1[pre], *supra* §IX.A.4.a.

- b. **5[A]: “a first reader antenna tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency”**

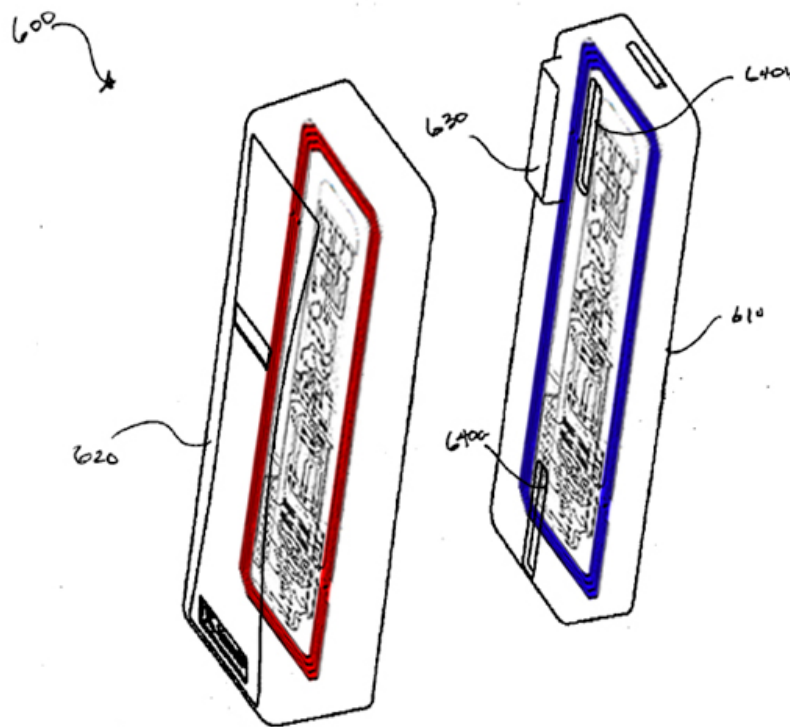
119. See Claim 1[A], *supra* §IX.A.4.b.

- c. **5[B]: “and a second reader antenna tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency”**

120. See Claim 1[B], supra §§IX.A.4.c.

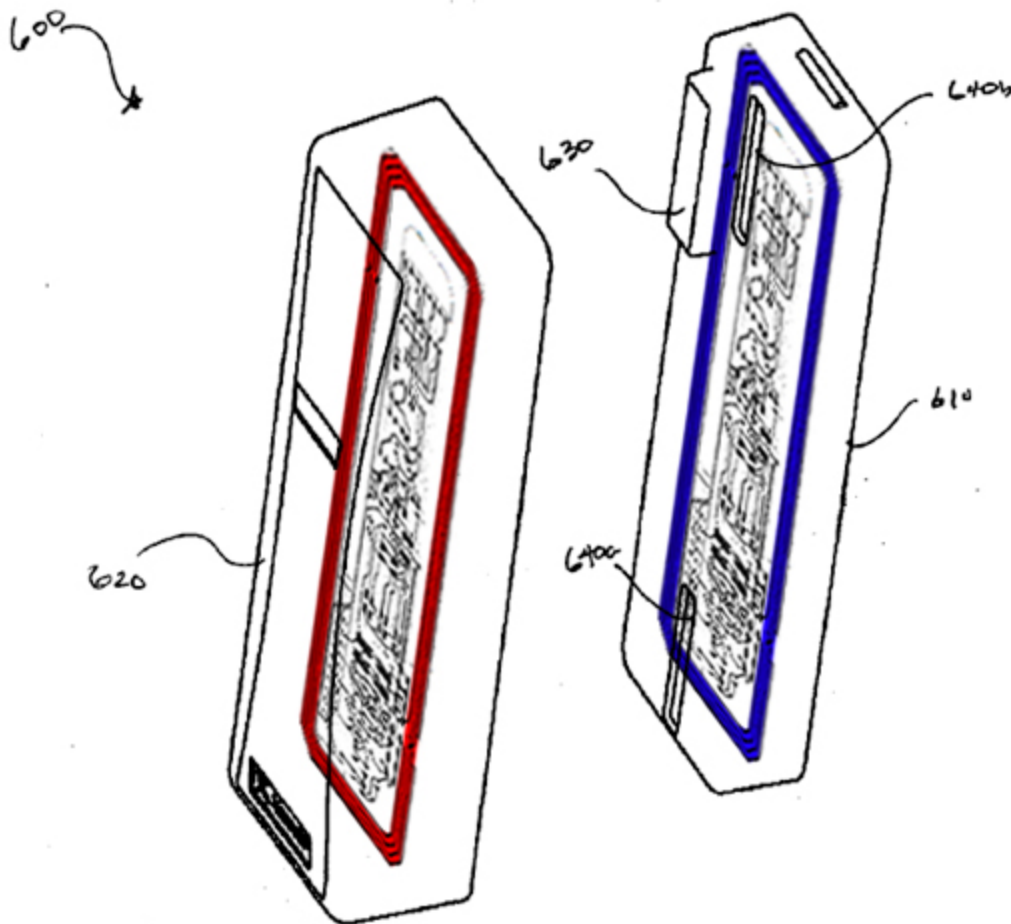
- d. **5[C]: “wherein said first and second antennas are arranged in at least a partially overlapping arrangement on proximate adjacent planes.”**

121. As described in Claims 1[A] and 1[B], Conlin discloses a multi-frequency reader in which the 13.56 MHz antenna (blue) is disposed on the plane of a circuit board within the base, and the 125 kHz antenna (red) is disposed on the plane of a circuit board within the cover, as shown below:



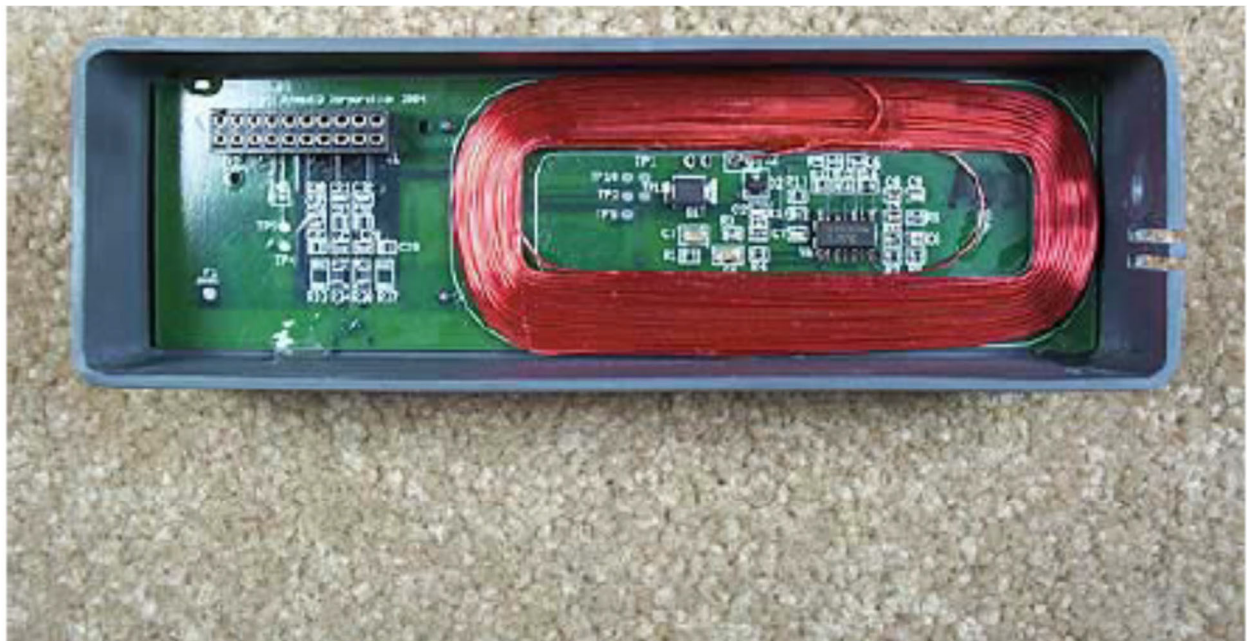
Supra, §§IX.A.4.b, c. Thus, Conlin discloses that the two antennas are on proximate adjacent planes.

122. When these antenna boards are arranged facing each other in the confines of the reader housing, as described in claim 1[C] they are in at least a partially overlapping arrangement.

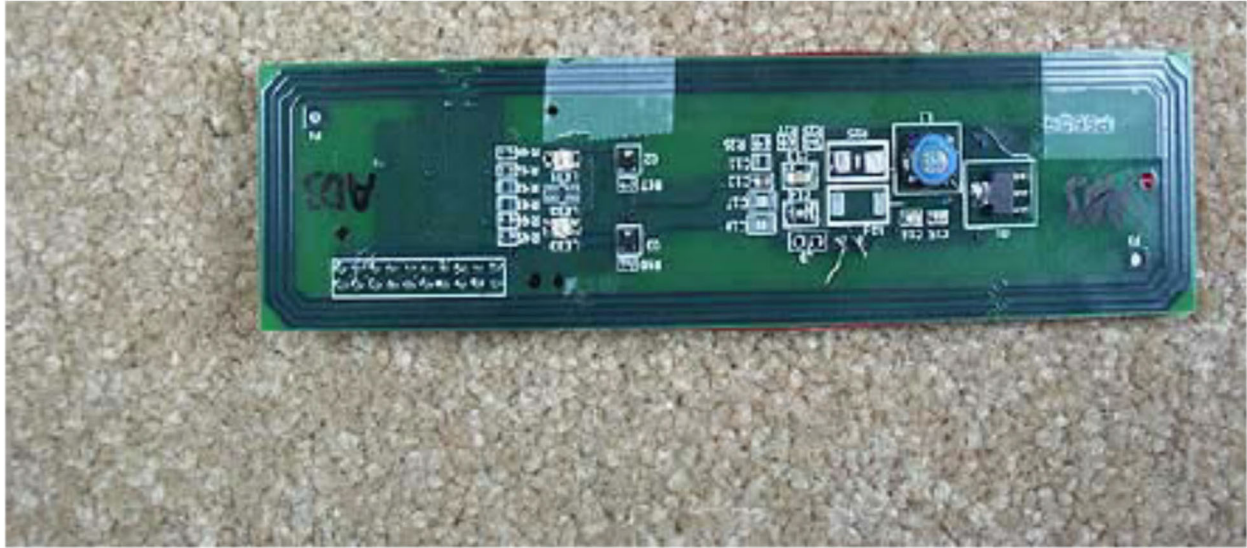


123. A POSITA would have known that the 125 kHz antenna and the 13.56 MHz antenna disclosed in Conlin could also be implemented on either side of a single circuit board. For example, I understand that the original assignee of

Conlin, XceedID, released a commercial embodiment of Conlin, known as the XF1100 Reader. *See* EX1028; EX1031, at 49-56, 63-66; EX1022, at 88 (“Plaintiffs [Patent Owner] admit that XF1100 grant of equipment authorization from the FCC is dated October 19, 2004.”) This particular commercial embodiment shows a reader with a printed circuit board with two antennas, one disposed on either side of the circuit board and that is placed in one portion of the reader housing (*see* EX1006, ¶¶[0026], [0046]; EX1007, at 6, 7 14, 41-42), as shown below in a 2004 submission to the Federal Communications Commission (FCC):



Antenna PCB Top



Antenna PCB Bottom

EX1027, at 3-4.

124. Thus, whether the two antennas were disposed on either side of a single circuit board or separately in the reader base and cover, as disclosed and suggested by Conlin, a POSITA would have known that it would be advantageous to dispose the antennas such that they would be arranged in at least a partially overlapping arrangement on proximate adjacent planes. Indeed a POSITA would have known that such orientation would have provided multiple advantages, including allowing for a compact assembly and housing, minimizing magnetic flux, and ensuring strong signal strength. *Supra*, §VI.C.

9. Claim 6: “The antenna array of claim 5, further comprising a reader housing containing said first and second antennas.”

125. *See* Claim 4, *supra* §IX.A.7.

10.Claim 14

a. 14[pre]: “An RFID reader for an RFID system comprising:”

126. Conlin discloses an RFID Reader. *See* Claim 1, *supra* §§IX.A.4.

Relating to the “RFID System,” both Conlin and the ’677 application disclose this element. Conlin teaches, for example, “providing an access control module that is operable to receive communications at two or more carrier frequencies. The methods further include providing [] a credential operable to communicate at one carrier frequency to replace an earlier provided credential that operates at a different carrier frequency.” EX1006, ¶[0009]; *see also id.* at abstract (“The disclosure describes various systems and methods for access control. One such method includes providing an access control module that is capable of operating at least a first carrier frequency and a second carrier frequency. In addition, the method includes providing a first access credential that operates at the first carrier frequency, and providing a second access credential that operates at the second carrier frequency”); EX1007; at 1 [title], 2, 5, 6, 9, 14 (fig. 10).

127. The ’677 application also discloses an “RFID system.” For example, the ’677 application discloses that “the present invention provides for modular contactless smart card access control readers that operate at multiple RF frequencies. For example, two or more frequencies can be supported including 125 KHz and 13.56MHz. This multiple frequency approach provides for

transitioning systems from one generation of control to another.” EX1007, at 5, *see also* 1 [title], 2, 14 [fig. 10], 6, 9.

- a. **14[A]: “an antenna array including a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency.”**

128. Conlin discloses this limitation. *See* Claim 1[pre], [A], 1[C] *supra* §§IX.A.4.a, b, d. The arrangement of multiple antennas in the base and/or update portion (snap-on cover) discloses an antenna array. *See id.*; *see also* Claim 14[C], *infra* §IX.A.10.c.

- b. **14[B]: “and a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,”**

129. *See* Claim 1[B], *supra* §IX.A.4.c.

- c. **14[C]: “wherein the first and second antennas are oriented along axes that are substantially parallel to one another**

130. *See* Claim 1[C], *supra* §IX.A.4.d.

- d. **14[D]: “and a signal generator coupled with said first and second reader antennas.”**

131. Conlin discloses this limitation. The incorporated-by-reference ’677 application discloses a “125 KHz analog front end,” and a “13.56 MHz communication engine,” which includes an “Analog Front End and processing.”

EX1007, at 33, 41-42. POSITA would also have understood that “analog front end” refers to a structure that includes a signal generator. *See, e.g.*, EX1026, at 1:35-2:31, 3:19-48. Conlin also discloses the use of “additional analog front end circuitry” on a PCB in the update portion. EX1006, ¶[0052]; EX1007, at 5, 6, 9.

132. The '677 application further discloses a reader containing a combined base and cover assemblies. The antennas for both 13.56 MHz and 125 kHz are located on an “Antenna Board,” which is contained in the cover. EX1007, at 42. The “125 KHz analog front end,” is also placed on the “Antenna Board” (EX1007, at 41-42), while the base portion has “Analog Front End” for 13.56 MHz (EX1007, at 33). The 13.56 MHz analog front end is connected to the Antenna Board, and thereby the 13.56 MHz antenna, by a “Connector interface to ‘Antenna Board.’” EX1007, at 33, *see id.* at 41-42, 5, 6, 9.

11. Claim 16: “The RFID reader of claim 14, wherein said signal generator includes a discrete first signal generator coupled with said first reader antenna for generating signals for transmission from said first reader antenna and a discrete second signal generator coupled with said second reader antenna separate from said discrete first signal generator for generating signals for transmission from said second reader antenna.”

133. Conlin discloses this limitation. As described above with respect to limitation 14D, each of the base and cover portions each contain a signal generator (an analog front end) directed to 13.56 MHz and 125 kHz, respectively, which are coupled individually to the reader antennas. *Supra*, §IX.A.10.d. These signal

generators generate signals for transmission from the each of the antennas. *Id.* Therefore, the '677 application discloses discrete signal generators for each antenna.

12. Claim 17

- a. **17[pre]: “An RFID reader for an RFID system comprising”**

134. *See* Claim 14[pre], *supra* §IX.10.a.

- b. **17[A]: “an antenna array including a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency”**

135. Conlin discloses this limitation. *See* Claim 1[pre], [A] [C], *supra* §§IX.A.4.a, b, d. The arrangement of a 13.56 MHz antenna in the base portion and a 125 kHz antenna in the update portion (snap-on cover) discloses an antenna array. *See* claim 17[C], *infra* §IX.A.12.d.

- c. **17[B] “and second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,”**

136. *See* Claim 1[B], *supra* §IX.A.4.c.

- d. **17[C]: “wherein the first and second antennas are arranged in at least a partially overlapping arrangement along proximate adjacent planes;”**

137. *See* Claim 5[C], *supra* §IX.A.8.d.

e. 17[D] “and receiver electronics coupled with said first and second reader antennas.”

138. Conlin also discloses this limitation. Conlin discloses that each antenna is connected to an analog front end and that the reader contains a “receiver breadboard,” which a POSITA would have understood as referring to structures that include receiver electronics.

139. In particular, the ’677 application discloses a “Receiver breadboard” for an “125 KHz Analog Front End” contained in the cover with the 125 kHz antenna, and an “Analog Front End” for the 13.56 MHz antenna contained in the base. EX1007, at 33, 41-42. The 13.56 MHz analog front end is connected to the “Antenna Board,” which contains the 13.56 MHz antenna, via the “Connector Interface.” *Id.* at 33, 41-42; *see also* 42, 5, 6, 9, 14, 15 -20, 31-33, 56.

140. A POSITA would have understood that the “analog front end,” as disclosed in Conlin and ’677 application as being connected to antennas (EX1006, ¶[0052]; EX1007, at 33, 41-42; *see also id.* at 42, 5, 6, 9, 14, 15 -20, 31-33, 56), refers to a structure that includes receiver electronics. *See, e.g.*, EX1026, at 1:35-2:31, 3:19-48. Indeed, it was well-known that analog communications received by the antenna are passed to the receiver electronics, which adjust the received analog data into a digital format that may be processed by the reader’s microcontroller. Electronics that are directed to receiving and “conditioning” incoming data signals often include bandpass filters, demodulators, and/or amplifiers, which respectively

filter incoming signals, extract data from incoming signals, and amplify the signals for conversion to digital data. *See id.*

- 13. Claim 19: “The RFID reader of claim 17, wherein said receiver electronics includes discrete first receiver electronics coupled with said first reader antenna for conditioning signals received by said first reader antenna and discrete second receiver electronics coupled with said second reader antenna separate from said discrete first receiver electronics for conditioning signals received by said second reader antenna.”**

141. Conlin discloses this limitation. As described in Claim 17[D], §IX.A.12.e, *supra*, each of the base and cover portions each contain an analog front end directed to 13.56 MHz and 125 kHz, respectively, which are coupled individually to the reader antennas. Therefore, the '677 application discloses discrete receiver electronics for each antenna.

14. Claim 20

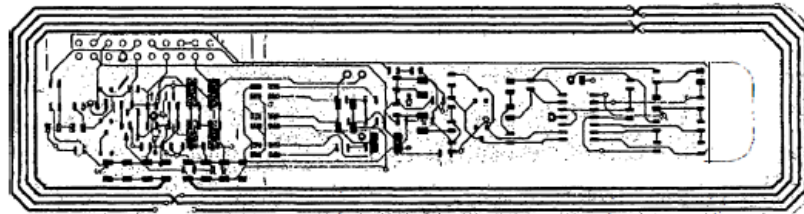
- a. 20[pre]: “An antenna array for an RFID reader comprising:”**

142. *See* Claim 1[pre], *supra* §IX.A.4.a.

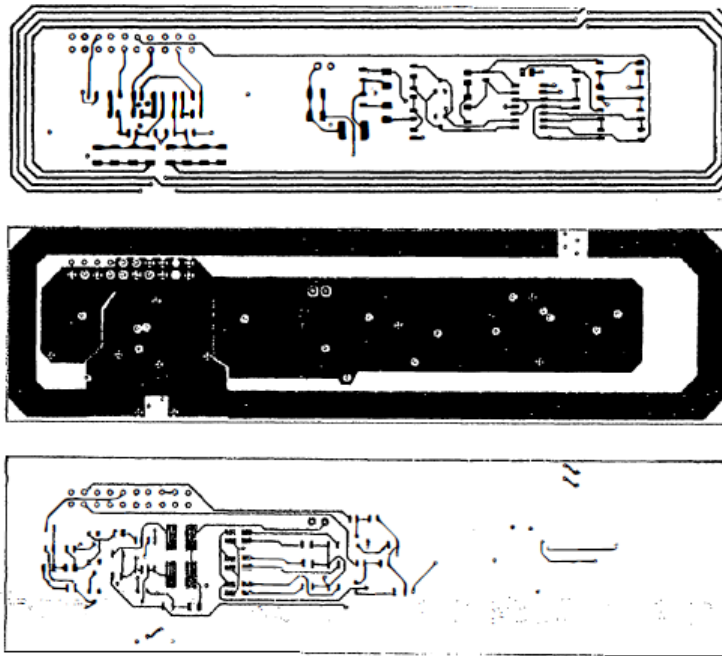
- b. 20[A]: “a first reader loop antenna having a first loop and tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;”
- c. 20[B]: “and a second reader loop antenna having a second loop and tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,”

143. The incorporated-by-reference '677 application discloses loop antennas suitable for 125 kHz and 13.56 MHz reader antennas:

Antenna Board Layout



Antenna Board Layout



EX1007, at 43-44; *see* Ground 1, Claims 1[A] and [B], *supra* §§IX.A.4.b, c.

- d. **20[C]: “wherein a first plane defined by the first area is substantially orthogonal to a direction of magnetic flux created through the first antenna, wherein a second plane defined by the second area is substantially orthogonal to a direction of magnetic flux created through the second antenna,”**

144. A POSITA would have understood Conlin to disclose this limitation. Even if not expressly disclosed, it would have been obvious to orient the antennas in Conlin so that a first plane defined by a first area is substantially orthogonal to a direction of magnetic flux created through the first antenna, and wherein a second plane defined by a second area is substantially orthogonal to a direction of magnetic flux created through the second antenna.

145. It was well known before the priority date that the direction of magnetic flux created by an antenna loop is perpendicular to the plane on which that antenna sits. EX1008 Figs. 4.2, at 15, 4.6 at 20, 4.7 at 20, 4.8 at 22, 4.11 at 25, 4.12 at 26, 4.24 at 35. The loops described with reference to claim 1[A] and [B] in Ground 1 surround first and second areas, respectively, each of which sits on and defines a separate plane. §§IX.A.4.b, c. It is inherent to the operation of loop antennas that the direction of magnetic flux created by each antenna is orthogonal to the plane on which that antenna sits, as a POSITA would have known. For example, the RFID Handbook demonstrates this behavior of loop antennas in Figure 4.3:

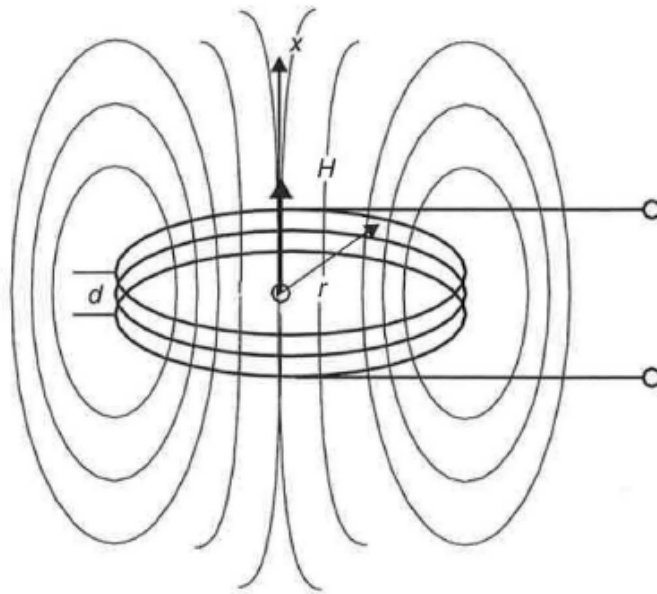


Figure 4.3 The path of the lines of magnetic flux around a short cylindrical coil, or conductor loop, similar to those employed in the transmitter antennas of inductively coupled RFID systems

EX1008, at 16.

- e. **20[D]: “wherein said first and second loops are arranged relative to one another such that a portion of the first area in the first plane overlaps a portion of the second area in the second plane.”**

146. The '677 application incorporated in Conlin discloses this limitation. Indeed, as described above, the '677 application discloses loop antennas on separate planes, which are overlapping. *See supra*, §§IX.A.8.d, IX.A.14.d.

B. Ground 2: Conlin in view of Walton Renders Obvious Claims 7, 9-11, 13, 22-24, and 26 of the '862 Patent

1. Walton

147. Walton issued on July 15, 1986, from an application filed on April 2, 1984. EX1023, Title Page. I understand that Walton is therefore prior art to the '862 Patent.

148. Walton “relates to an electronic proximity identification and recognition system . . . wherein there is no physical contact between the identification card and recognition apparatus.” EX1023, 1:8-12. The identification card may have “an electronic circuit embedded therein” and an “individual possessing the card may position it adjacent a door that they want to enter.” *Id.*, 1:28-31. “A recognition device may be arranged to control the door latch.” *Id.*, 1:31-32.

149. Walton discloses a system having an “identification section and recognition section each have a sending and a receiving antenna,” wherein the

“antennas in each section are structured to have virtually zero mutual inductance.”

EX1029, Abstract.

150. Walton recognizes that the “reader (recognition station), which is typically stationary, must send an interrogation signal and/or power to the identifier device (e.g., card, tag, key), which is typically portable.” EX1029, 2:9-12. “In response, the identifier device sends a coded signal bearing intelligence about its identification to the reader.” *Id.*, 2:12-14.

151. Walton discloses that “[m]eans must be provided so that the two directions of communication and power do not interfere to the extent of inhibiting the desired transfers.” EX1029, 2:14-17.

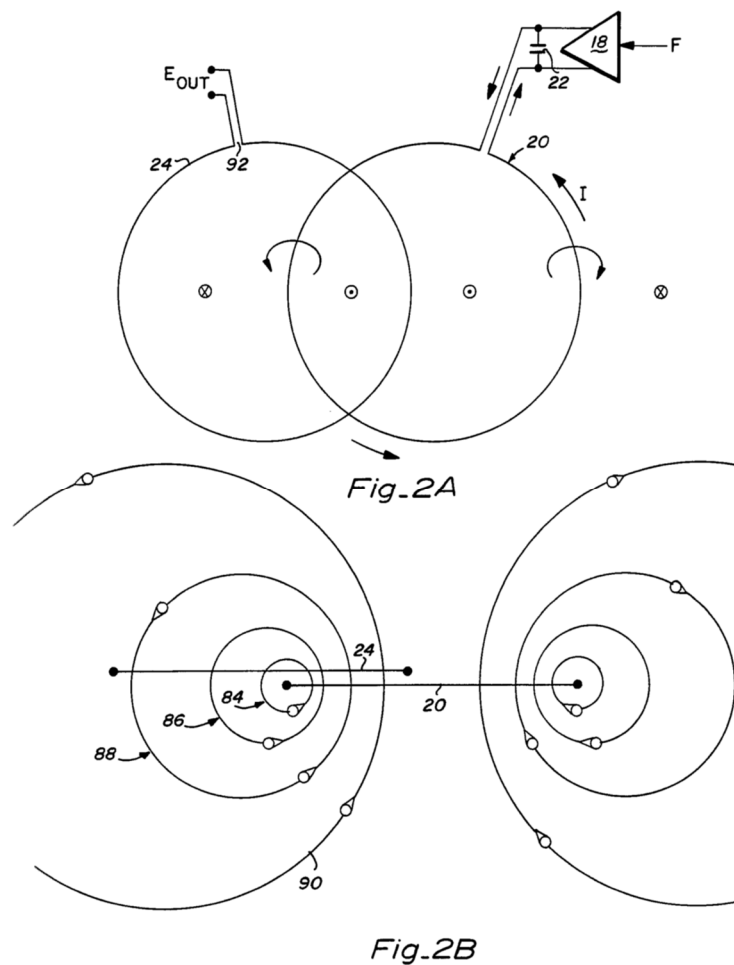
152. Walton discloses “separate coils” within the reader “designed to have zero mutual inductance.” EX1029, 2:59-61. “Zero mutual inductance between coil antennas in the reader . . . is realized by placing coils together with the proper amount of overlap.” *Id.*, 2:63-66.

153. Walton discloses that different frequencies also may be used. *Id.*, 2:66-67. “One frequency which has been found suitable” is 13.56 MHz. *Id.*, 3:39-40. “The frequency F_2 is typically lower than F_1 and is chosen high enough to be capable of efficiently radiating intelligence. . . .” *Id.*, 4:26-30.

154. Walton discloses a “reader coil antenna 24 [] positioned to be adjacent to and overlap the coil antenna 20, and is positioned such that the flux lines

generated within coil antenna 24 from coil 20 are totally self-cancelling and no voltage from the coil antenna 20 is induced into the reader coil antenna 24.” *Id.*, 3:49-54.

155. FIGS. 2A and 2B of Walton show “positioning of the coils 20 and 24 relative to one another so as to establish zero mutual inductance.” *Id.*, 4:5-7. FIG 2A is “the top view of two coils 20 and 24” and FIG 2B is “the side view of the two coils which are designed to have zero net shared flux, or zero mutual inductance.” *Id.*, 4:7-11:



156. The above figures show “the coil 24 in a plane slightly above the plane of the coil 20 and with partial overlap of the two coils.” *Id.* 4:11-13.

157. Walton discloses that “[b]ased on the right-hand thumb rule, flux lines wrap the turns of the coil 20 thereby producing an upward flux field through the center of coil 20 and a downward field outside of coil 20.” *Id.* 4:15-19 (flux lines labeled as 84, 86, 88, and 90). “The voltage induced in the coil 24 from the coil 20 is proportional to the net flux intersections from the coil 20 through the coil 24.” *Id.*, 4:22-24. Thus, the “net flux is close to zero.” *Id.*, 4:27.

158. Walton recognizes that “[i]f the coil 24 were moved further to the left, the upward flux lines 88 and 90 would not intersect with coil 20 whereas their downward values would,” which would “result in a net downward or negative flux through the coil antenna 24. *Id.*, 4:27-31. “If the coil antenna 24 is moved further to the right, the downward parts of the flux lines 86 and 88 would no longer intersect the coil antenna 24, but the upward lines of the flux lines 88 and 90 would, for a net upward or positive flux through the coil antenna 24.” *Id.*, 4:32-36.

159. Walton is in the same field as the ’862 patent because Walton relates to readers using radio frequency reader systems used for access control. *Id.*, Abstract, 1:7-24. Walton is pertinent to the problems the ’862 patent purportedly addresses because Walton is directed to a reader having two antennas that each

uses a different frequency while having zero mutual inductance. *Id.* at Abstract, 2:39-3:5. Walton therefore is analogous art to the '862 patent.

160. As discussed further below, a POSITA implementing a multi-frequency reader as disclosed in Conlin would have been motivated to look to the teachings of Walton to ensure that magnetic flux between the two antennas would be minimized while allowing for a compact reader housing and strong signal strength between the reader and cards operating at either high or low frequencies.

2. Claim 7:

a. “The antenna array of claim 5,”

161. As discussed above, Conlin renders obvious claim 5. *Supra*, §IX.A.6.

b. “wherein said first reader antenna has a first area, said second reader antenna has a second area, and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”

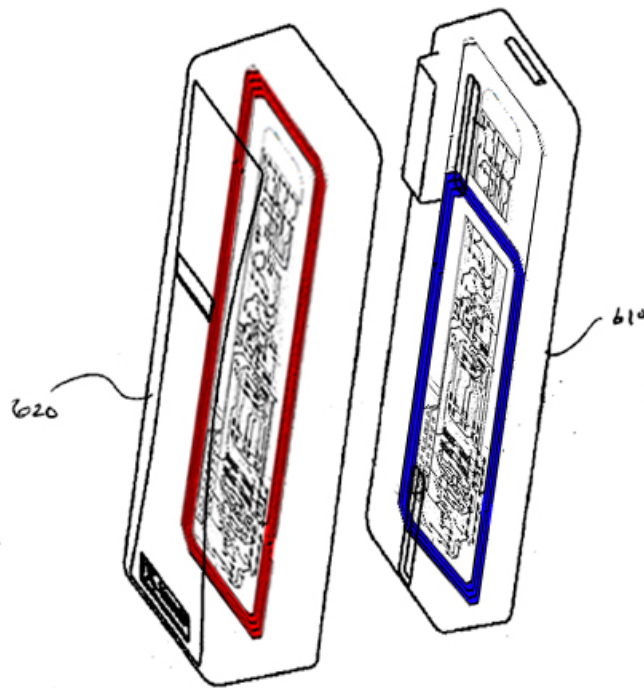
162. As described below, a POSITA would have been motivated by Walton’s teachings to modify the antennas placed on proximate adjacent planes of the opposing sides of a circuit board or on circuit boards placed in the snap-on cover and base portion described in Ground 1, Claim 5 by shortening one of the antenna loops such that it does not extend along the entirety of the length of the circuit board on which it is printed in order to reduce the extent of the overlap of

the two antennas and thereby reduce the magnetic field interactions between the antennas. *Infra*, §IX.B.3.

163. To improve performance of the RFID Reader described in the '677 application, a POSITA would have been motivated to modify the circuit and antenna boards disclosed in the '677 application to minimize the magnetic field interactions between the antennas. The risk presented is that the magnetic field generated by one antenna may induce a current in the other antenna, which thereby would create its own magnetic field and disrupt the first antenna's capabilities to transmit and receive data to and from a credential, as taught by Walton. *See* EX1023, at 2:6-36, 2:43-3:2, 5:5-43; *see also* EX1024, at 1:31-40, 2:48-3:2.

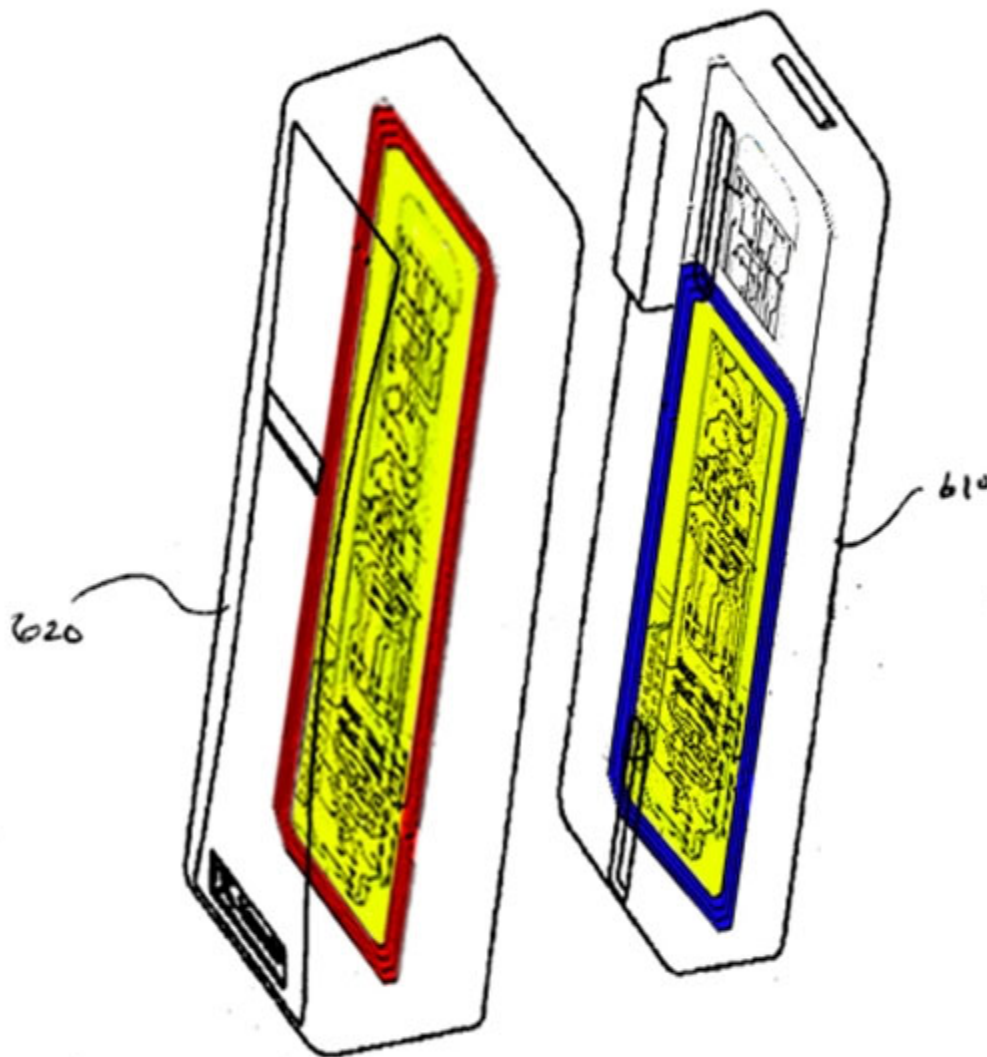
164. A POSITA would have known that by modifying the antenna loops shown below to instead cover a portion of the circuit board, instead of covering the entire perimeter of the planar circuit board, this would reduce magnetic field interactions between the antennas. Either the 125 kHz or 13.56 MHz reader antenna could be shortened to form a loop that spans less than the full length of the printed circuit board, so long as at least a minimal read range is maintained, often in the range of 1.5 inches from the reader. *See* EX1033, at 2; EX1009, at 2. For example, a POSITA would have known that the low-frequency antenna, which typically requires a high number of windings, could advantageously be disposed along the entire perimeter of the circuit board in the cover, while the high-

frequency antenna, which typically requires relatively fewer windings, could therefore advantageously be disposed in the reader base so that it spans less than the full length of the circuit board. In doing so, the shortened antenna would cause less interference in the un-shortened antenna. *See* EX1023, at 2:6-36, 2:43-3:2, 5:5-43.



EX1006, at Fig. 6 (annotated); EX1007, at 7, 9-10, 37-38, 41. In this arrangement, exemplified in annotated Figure 6, below, the 125 kHz antenna (red) would have a first area (yellow), the 13.56 MHz antenna (blue) would have a second area (yellow), and the antennas would be arranged relative one another such that only a portion of the first area aligns with only a portion of the second area. A POSITA would have known that such a partially overlapping arrangement of the

antennas would be advantageous as it would provide the benefits of reduced magnetic field interference between the two reader antennas, which provides the reader with a higher degree of precision when reading credentials, while still maintaining a small overall reader size.



See EX1006, ¶[0045], Fig. 6; *see also id.* ¶[0054]; EX1007, at 7, 9-10, 37-38, 41.

165. Such a modification would be of use, for example, in RFID reader systems that require a high degree of precision in the ability to read large volumes of data from transponders, in systems requiring an extended interrogation field, or in systems where data processing capabilities are less sophisticated.

166. Making this obvious modification would result in only a portion of one antenna being overlapped by the other antenna, which orients the antennas such that the central portion of one antenna, which is the area of highest magnetic field strength, overlaps and thereby interacts less than with the entirety of the center area of the other antenna. *See, e.g., Ex. 1008, Fig. 4.24:*

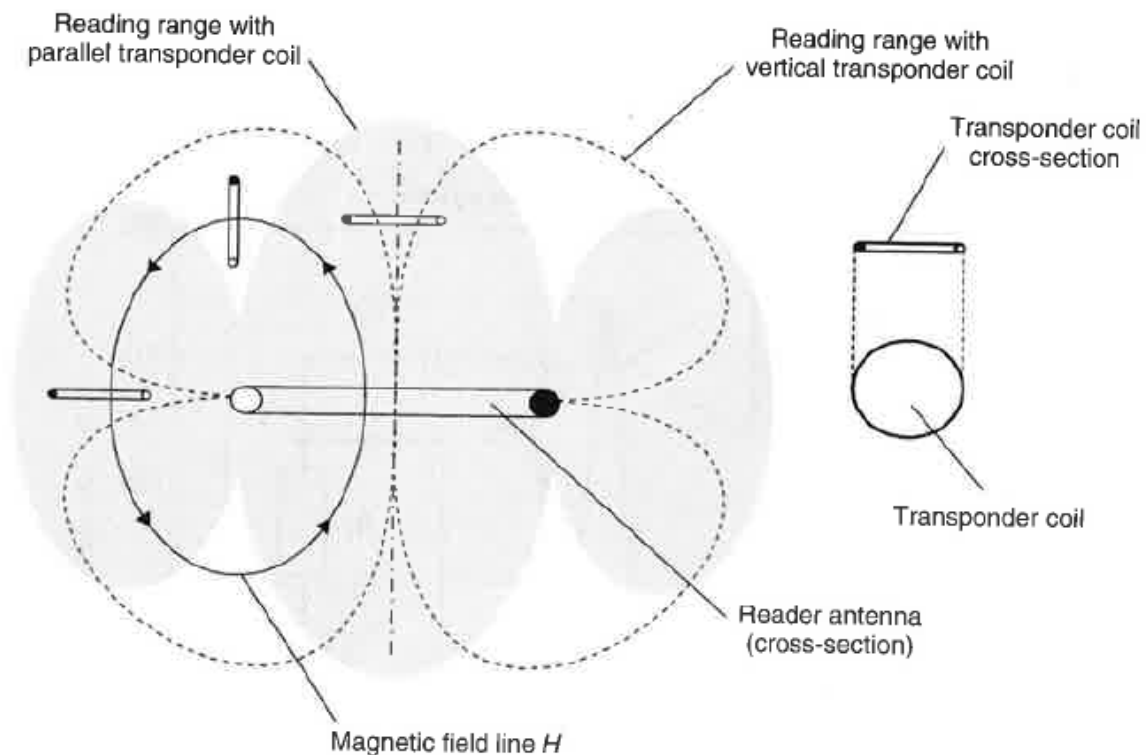


Figure 4.24 Interrogation zone of a reader at different alignments of the transponder coil

167. Further, by maintaining as large a diameter in the loops formed by the antennas as possible, this would permit the antennas to have as substantial read range as possible within the housing provided. *Id.* at 85.

168. A POSITA would have been also motivated to place the antennas in the orientations described immediately above due to limited design options for integrating antennas in an RFID Reader. Indeed, a POSITA would have been motivated to form an antenna loop that is as large as possible in the space provided. EX1008, at 62-70. Considering that there may be other electronics placed in the reader or other design features of the housing that do not allow the antenna to form a loop around the entirety of the available space in a housing (*see id.* at 43; EX1027), it is often the case that a POSITA would design an antenna that forms a loop encompassing only a portion of the available space. A POSITA would have known that in view of the known magnetic field interactions between the antennas, orienting the antennas in the manner described above would have been an obvious design choice, and would lead to predictable results. EX1023, 5:21-43; *see also* EX1008, at 61-85; EX1024, 1:31-40, 2:48-3:2.

169. Such a modification to the design of the circuit and antenna boards would have been within the skill of a POSITA. A POSITA would have taken several classes in circuit design, including in radio-frequency circuit design. Further, a POSITA would have been able to design and test the combined reader

through the circuit board and antenna modeling and simulation programs available at the time, as well as through physical prototypes. Further, modifying the locations of the electronic components is an entirely predictable undertaking, and there is no reason not to expect success in the re-design of the printed circuit board and antenna board as needed to place the antennas in these arrangements or avoid any undesirable magnetic effects on reader electronics. Any effect on the read range caused by shortening the length of the antenna would be minimally affect the ability of the reader to read, and could be compensated for by placing that antenna closer to credentials to be read and an increased read strength within the shortened range.

170. Because magnetic field interactions between antennas was well understood by 2003, this modification would have been within the skill of a POSITA and the results only would have been the reduction in interference between the two antennas. Further, any reduction in read range caused by reducing the size of one antenna could be compensated for easily by placing that antenna closer to the location a credential is presented to be read and increased magnetic field strength within that read range. *See* EX1008, at 62-70.

3. Claim 9

a. 9[pre]: “An antenna array for an RFID reader comprising:”

171. *See* Claim 1[pre], *supra* §IX.A.4.a.

- b. **9[A]: “a first reader antenna tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;”**

172. See Claim 1[A], *supra* §IX.A.4.b.

- c. **9[B]: “and a second reader antenna tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency”**

173. See Claim 1[B], *supra* §IX.A.4.c.

- d. **9[C]: “wherein said first and second antennas are arranged in an opposing magnetic flux arrangement.”**

174. Walton teaches this limitation. Indeed, as discussed below, the concept of arranging two antennas in an opposing magnetic flux arrangement was well known long before the Priority Date.

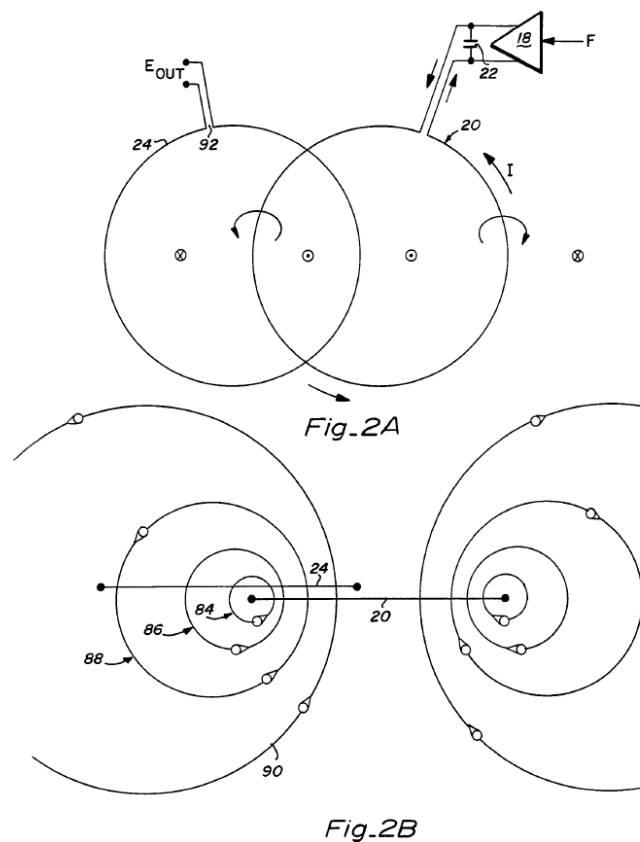
175. It was well understood before the Priority Date that currents flowing through conductor loops (i.e., an antennas) located in the vicinity of one another may affect the magnetic flux of the loops, respectively, and thereby impact reader range. EX1008, at 68-85; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2. It also was a well-known desire to reduce mutually induced magnetic flux, also referred to as magnetic coupling, so as to reduce any negative impacts to reader performance. For example, it was known that magnetic coupling could impede read range and could even prevent the reader from reading data sent from a credential due to magnetic field interference by one antenna with the magnetic field transmission

from the credential. EX1023, 2:6-36. Thus, a POSITA would have been motivated to implement the antennas disclosed in the '677 application so as to eliminate any negative impact of magnetic flux, which was routinely accomplished by separating conductors in close proximity as much as practicable. *See* EX1008, 64-65; EX1025, at 1-6.

176. In the field of RFID readers, design considerations dictate a small and compact reader housing, as well as a reader face that allows a user to simply and intuitively approach a reader and physically position a credential card near the reader so that it aligns with the internal antenna(s) and their limited range. A POSITA would have considered it an obvious implementation detail to orient the antennas disclosed in Conlin to allow for partial antenna overlap (as opposed to complete antenna overlap); indeed, a POSITA would have known that this could advantageously and easily be achieved by orienting a smaller area formed by one antenna within a larger area of another other antenna, or by staggering the overlapping antennas. EX1023; EX1024; EX1008. I note that the '862 patent itself recognizes that such orientating results in these opposing magnetic flux arrangements. '862 Patent, 12:55-58 (Figs. 3A, 3B) and col. 14:9-30 (Figs. 6A, 6B).

177. Walton, filed in 1984, discloses two parallel antennas disposed in a partially overlapping arrangement in order to reduce magnetic flux interference.

See EX1023, at 5:5-43, Figs. 2A and 2B . Walton teaches the use of an identification card reader that may be used in connection with access control and security. *See id.*, 1:25-36; 4:5-8; 3:24-29. The reader unit contains two loop antenna coils: “a coil for sending power and a separate coil for receiving data.” 2:56-59; 3:48-59. There is a “partial overlap of the two coils,” as shown in Figs. 2A and 2B below:



Id. 5:11-13; *see also id.* 2:63-66 (“Zero mutual inductance between coil antennas in the reader and between the coil antennas in the identifier is realized by placing coils together with the proper amount of overlap.”); 3:48-59 (“A reader coil antenna 24 is positioned to be adjacent to and overlap the coil antenna 20”);

1:49-56 (“A reader coil antenna 24 is positioned to be adjacent to and overlap the coil antenna 20”)

178. The two antennas may operate at different frequencies—coil 20 transmitting power at one frequency (F_1) and coil 24 receiving data signals at another, typically lower frequency (F_2). *Id.* 3:34-40 (“The frequency F_1 may be within one of various ranges suitable for transmitting power to the identification section 14. One frequency which has been found to be suitable for F_1 is 13.56 MHz”); 3:67-65 (“Tied across the capacitor 26 is a receiver amplifier 28 which has an automatic frequency control circuit to track a predetermined carrier identification frequency F_2 which is of a value different than frequency F_1 .”); 2:66-67 (“Also, different frequencies may be used in the two directions.”); 4:24-28 (“The frequency F_2 is typically lower than F_1”).

179. Walton describes ways to align the two antennas, and how the area of overlap of the antenna loops may be adjusted in order to manage and minimize the magnetic flux through the other antenna. With reference to Fig. 2B, Walton describes the effects of antenna alignment on the amount of mutual inductance or induced voltage.

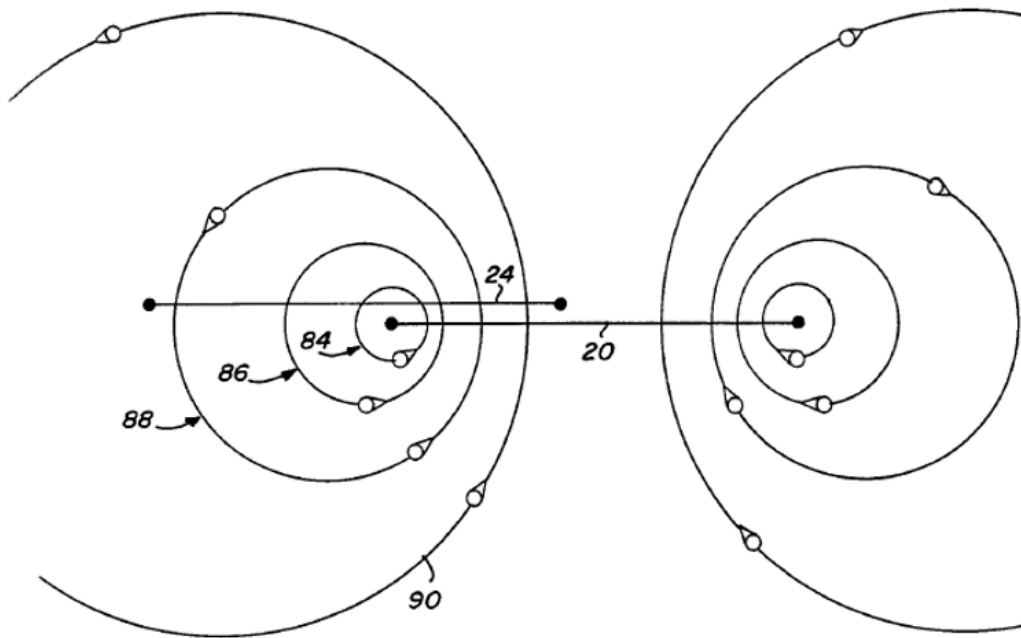


Fig.2B

Id., Fig. 2B. Walton discloses that “[t]he coil 24 is intersected by the flux lines of fields 84, 86, 88 and 90. The voltage induced in the coil 24 from the coil 20 is proportional to the net flux intersections from the coil 20 through the coil 24. The induced voltage . . . is measured at a gap 92 [(shown in Fig. 2A above)] in the coil antenna 24. The coil antenna 24 is located in FIGS. 2A and 2B where the net flux is close to zero. If the coil 24 were moved further to the left, the upward flux lines 88 and 90 would not intersect the coil 20 whereas their downward values would. This would result in a net downward or negative flux through the coil antenna 24. If the coil antenna 24 is moved further to the right, the downward parts of the flux lines 86 and 88 would no longer intersect the coil antenna 24, but the upward lines

of the flux lines 88 and 90 would, for a net upward or positive flux through the coil antenna 24. The coil antenna 24 is shown judiciously located for zero net flux, or zero mutual inductance. Flux and voltage affects in coil 20 are not coupled to the coil 24. By symmetry, the affects in coil 24 are not induced in the coil antenna 20.”

Id. 5:21-41. Through this teaching, a POSITA would have understood that maximal magnetic flux is reached if the antennas are of identical size and are arranged in an entirely overlapping arrangement, and that a partially overlapping arrangement (either where the antennas both partially overlap each other or where one antenna is entirely encircled by the other) results in reduced magnetic flux, with zero induced voltage being achieved where an antenna symmetrically intersects the positive and negative magnetic flux of the other antenna.

180. Indeed, Walton directly teaches that “**symmetry**” in the positioning of one antenna with respect to the magnetic field lines of the other antenna results in “zero mutual inductance,” because both downward and upward flux lines 88, 86 intersect the coil antenna 24, as shown in Fig. 2B. EX1023, at 5:36-40 (bolded emphasis added); see also id. at 5:32-36 (“If the coil antenna 24 is moved further to the right, the downward parts of the flux lines 86 and 88 would no longer intersect the coil antenna 24, but the upward lines of the flux lines 88 and 90 would, for a net upward or positive flux through the coil antenna 24.”).

181. I note that these disclosures from Walton directly teach the “opposing magnetic flux arrangements” shown in Figs. 3 and 6 of the ’862 patent, which are described as being opposing magnetic flux arrangements.

182. For example, these disclosures from the much-earlier Walton patent are precisely what the ’862 patent describes with respect to its Figures 6A and 6B:

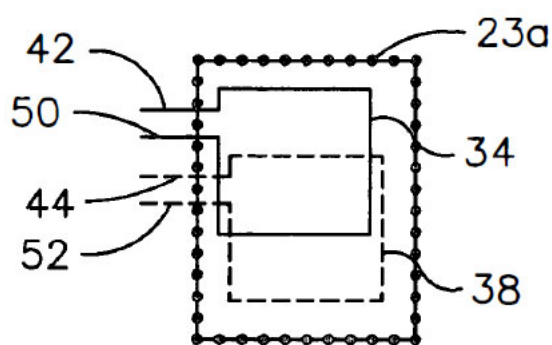


Fig. 6A

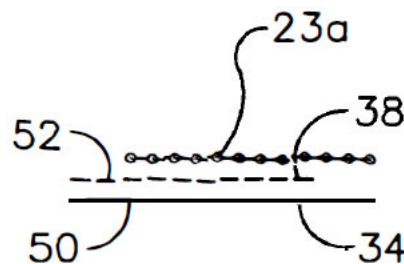


Fig. 6B

Ex. 1001, Figs. 6A, 6B. The ’862 patent discloses that an “opposing magnetic flux arrangement” where “reader antennas 34, 38 are arranged relative to one another such that essentially half the total area of the reader low frequency antenna 34 aligns with essentially half the total area of the reader high frequency antenna 38.”

Id. at 13:61-14:2. In this arrangement, “[t]he same magnitude of magnetic flux generated by the reader low frequency antenna 34 in the positive and negative directions passes through the reader high frequency antenna 38 and similarly the

same magnitude of magnetic flux generated by the reader high frequency antenna 38 in the positive and negative directions passes through the reader low frequency antenna 34,” which causes the magnetic fluxes to “cancel out essentially in their entirety.” EX1001, at 14:9-20. As described above, Walton disclosed this same solution to minimizing magnetic flux approximately 20 years before the ’862 patent.

183. Similarly, Walton teaches the opposing magnetic flux arrangement recognized in Figures 3A and 3B of the ’862 patent. Just as reader antenna coil 24 intersects both downward and upward flux when oriented on the right side of the antenna coil 20, antenna coil 24 would also experience net zero magnetic flux if it were oriented such that it overlapped the entirety of antenna coil 20—because the upward and downward flux originating from each of the right and left portions of antenna coil would cancel out across the entirety of the extended antenna coil 24, as shown below where antenna coil 24 (red) is modified to overlap the entirety of antenna coil 20.

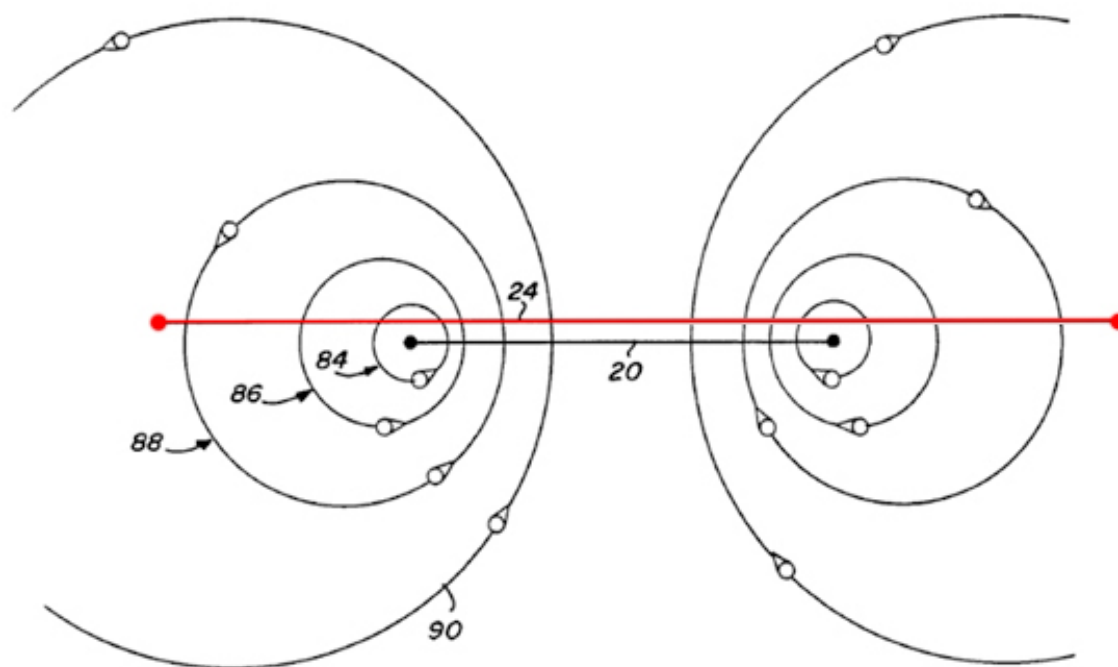


Fig. 2B

See EX1023, at 5:21-43. This results in an arrangement where coil 24, which receives signals at a lower frequency than the frequency by which the coil 20 transmits signals, completely encircles coil 20. A POSITA would have understood that this teaches the “opposing magnetic flux arrangement” disclosed with reference to Figs. 3A and 3B of the ’862 patent, where “[t]he reader antennas 34, 38 are arranged relative to one another such that the area of the reader high frequency antenna 38 fits entirely within the area of the reader low frequency antenna 34” and the magnetic flux passing through the low frequency antenna 34.” EX1001, 12:36-44. “As a result [of this arrangement], the positive and negative magnetic fluxes generated by the reader high frequency antenna 38, which pass

through the reader low frequency antenna 34, cancel out, summing to essentially zero.” *Id.* at 12:52-55.

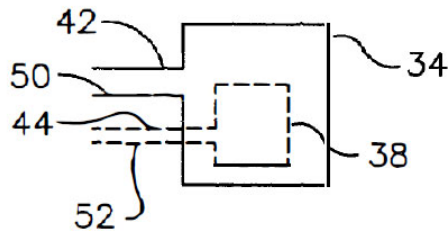


Fig. 3A

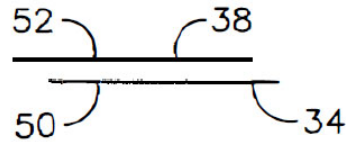


Fig. 3B

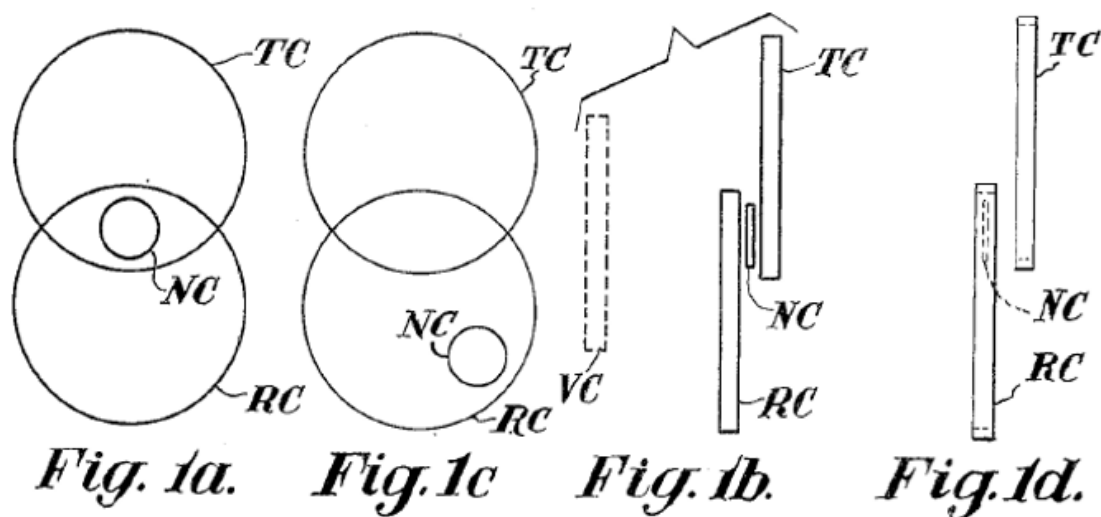
184. A POSITA implementing a multi-frequency reader as disclosed in Conlin would have been motivated to look to Walton’s teachings described above. Both Conlin and Walton are directed to similar objectives—providing a multi-frequency reader for access control with strong signal strength (*see* EX1006, ¶¶[0023], [0049]; EX1007, at 5, 8; EX1023; 2:6-36; 3:15-5:43) where multiple antennas are placed in close proximity (*see* EX1006, ¶¶[0046], [0052], EX1007, at 5, 6, 9, 14 (Fig. 10), 33, 41-42; EX1023, 2:6-36, 5:5-43; Figs. 2A and B)—and Walton’s teachings regarding antenna orientation are consistent with Conlin’s teachings regarding disposing a low-frequency antenna in a reader cover and a high-frequency antenna in a reader base. Moreover, a POSITA would have been motivated to combine Conlin and Walton in order to reduce the effects of magnetic flux on RFID readers. *See* EX1006, ¶¶[0023], [0049], EX1007, at 5, 8; EX1023;

2:6-36; 3:15-5:43. Indeed, a POSITA would have known that by placing two or more antennas within each of an update portion or a base portion, the magnetic fields of each antenna may interact with the other antenna. *See* EX1006, ¶¶[0046], [0052], EX1007, at 5, 6, 9, 14 (Fig. 10), 33, 41-42; EX1023, 2:6-36, 5:5-43; Figs. 2A and B. In order to further improve reader performance, a POSITA would have been motivated to look to the teachings of Walton, which describe how to reduce any induced voltage caused by the magnetic flux of one antenna in another antenna. A POSITA would have known this to provide the benefits of increased read reliability and would produce a more consistent, reliable product, that would be desirable in the marketplace. A POSITA would have known that Walton's teachings could be easily implemented with Conlin's reader, and would have been motivated to apply these teachings to minimize magnetic flux between the two antennas while allowing for a compact reader housing and strong signal strength between the reader and cards operating at either high or low frequencies.

185. Indeed, these concepts go back decades. For example, U.S. Patent No. 2,779,908 (the '908 patent), filed in 1952, also discloses antennas in an "opposing magnetic flux arrangement." The '908 patent recognizes that a minimal area of overlap for "relatively large diameter," air-core antennas should "normally [result in] no magnetic coupling form one coil to the other" EX1024, 1:32, 2:58-60; *see also id.*, 1:31-40 ("[I]t has been found that when air-core coils of relatively

large diameter are involved, and the coils are arranged so as to overlap one another as a result of the coils being placed in close proximity, it is not possible to reduce the coupling to zero by placing the coils [at an angle with respect to each other]. In this case, the coupling between the coils is reduced by overlapping the coils so that about 20% of their diameter are overlapped, but it has been found that some coupling usually still exists even with this placement.”); 2:48-3:2.

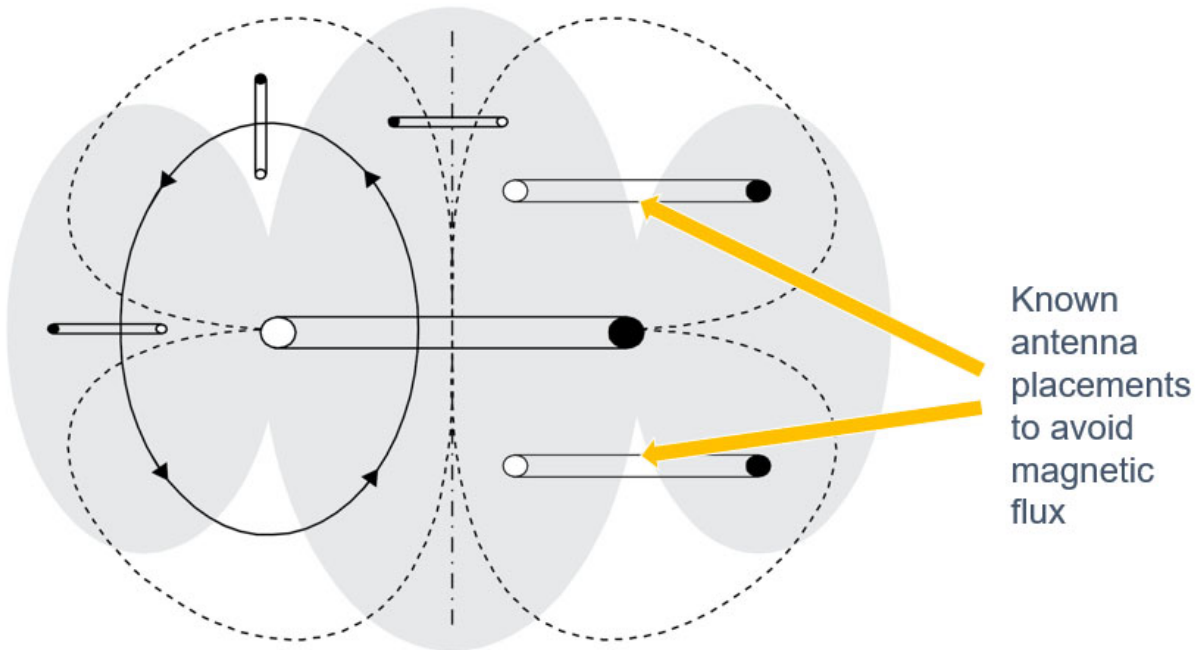
186. Figures 1a through 1d of the '908 patent disclose a “transmitting coil TC and receiving coil RC ... disposed in such manner that the coils are aligned vertically and ... overlapped to about 20% of their diameters”:



Id. at 2:48-57. The '908 patent discloses that this arrangement of coils should normally prevent any “magnetic coupling from one coil to the other.” *Id.* at 2:58-60. The '908 patent further notes that while it has been found that a small amount of coupling may nonetheless exist, this can be solved by introduction of a

neutralizing coil. *See id.* at 2:61-3:2 (“However, it has been found that a small amount of coupling usually exists, presumably due to the geometry of the coils and small amounts of current-carrying material in the coil construction [T]he introduction of a neutralizing coil [NC] which may consist of a single short-circuited turn of suitable diameter and resistance when properly positioned with respect to the transmitting and receiving coils, will reduce the coupling normally existing between the two coils to an amount that cannot be detected by the usual laboratory instruments.”).

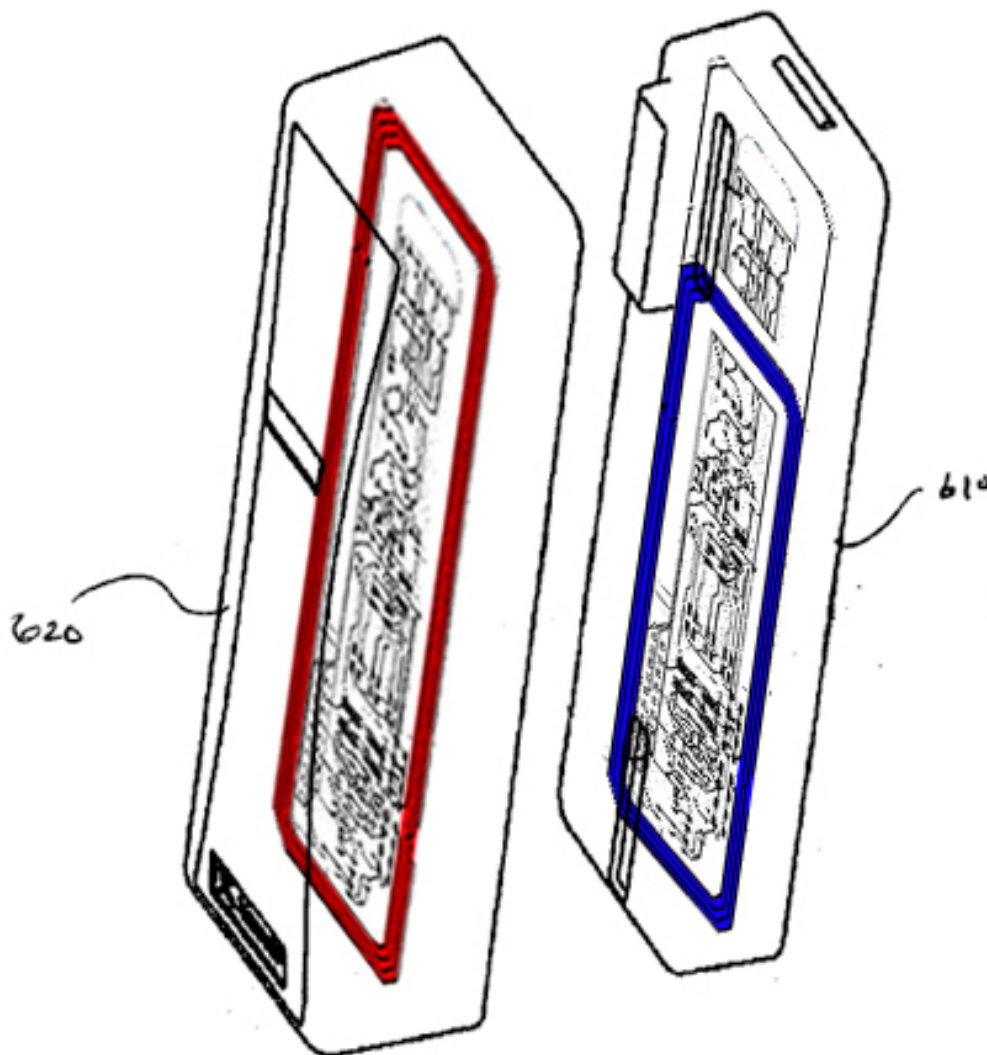
187. Additionally, the RFID Handbook shows the interrogation zone around a reader loop antenna based on the orientation of a transponder antenna coil to the reader coil. The interrogation zone refers to the “bending of the *magnetic field lines* in the entire area around the reader coil” where, at various angles, a transponder may be read. EX1008, at 34-35 (emphasis original). As shown in the gray circles, the interrogation zone—and thus magnetic field strength—is strongest in the area encircled by the antenna. The RFID Handbook teaches that if a second reader antenna were to be placed in a parallel with the reader antenna of Figure 4.24, the second antenna would experience the highest amount of magnetic coupling if it were placed such that the area of both antennas completely overlap, but the antennas would experience less coupling if the antennas only partially overlapped, as shown in the annotated Figure 4.24 below.



EX1008, at 85.

188. In sum, a POSITA would have understood from Walton's teachings that completely overlapping two antennas would have resulted in maximal magnetic inductance due to the high amount of positive magnetic flux. *See* EX1023, at 5:21-42; *see also* EX1024, 1:31-40; 2:48-52; EX1008, 84-85. A POSITA would have known to reduce the total magnitude of magnetic flux by therefore aligning the antennas in a partially overlapping arrangement (as opposed to complete antenna overlap). *Id.* Although having zero antenna overlap would reduce magnetic flux even further, a POSITA would have known that having two antennas in a non-overlapping orientation would have resulted in an undesirable larger total reader size, as the '862 patent recognizes *See* EX1001, at 11:46-65.

189. Accordingly, a POSITA implementing the teachings of Conlin would have been motivated to orient the antenna board in the reader base (including the 13.56 MHz antenna) and the antenna board in the cover (including the 125 kHz antenna), such that the 125 kHz antenna and the 13.56 MHz antennas would be arranged in an opposing magnetic flux arrangement, as shown in the annotated figure below:



4. **Claim 10: “The antenna array of claim 9, further comprising a reader housing containing said first and second antennas.”**

190. *See* Ground 1, Claim 4, *supra* §IX.A.7.

5. **Claim 11:**

- a. **The antenna array of claim 9,**

191. *See* Ground 2, Claim 9, *supra* §IX.B.5.

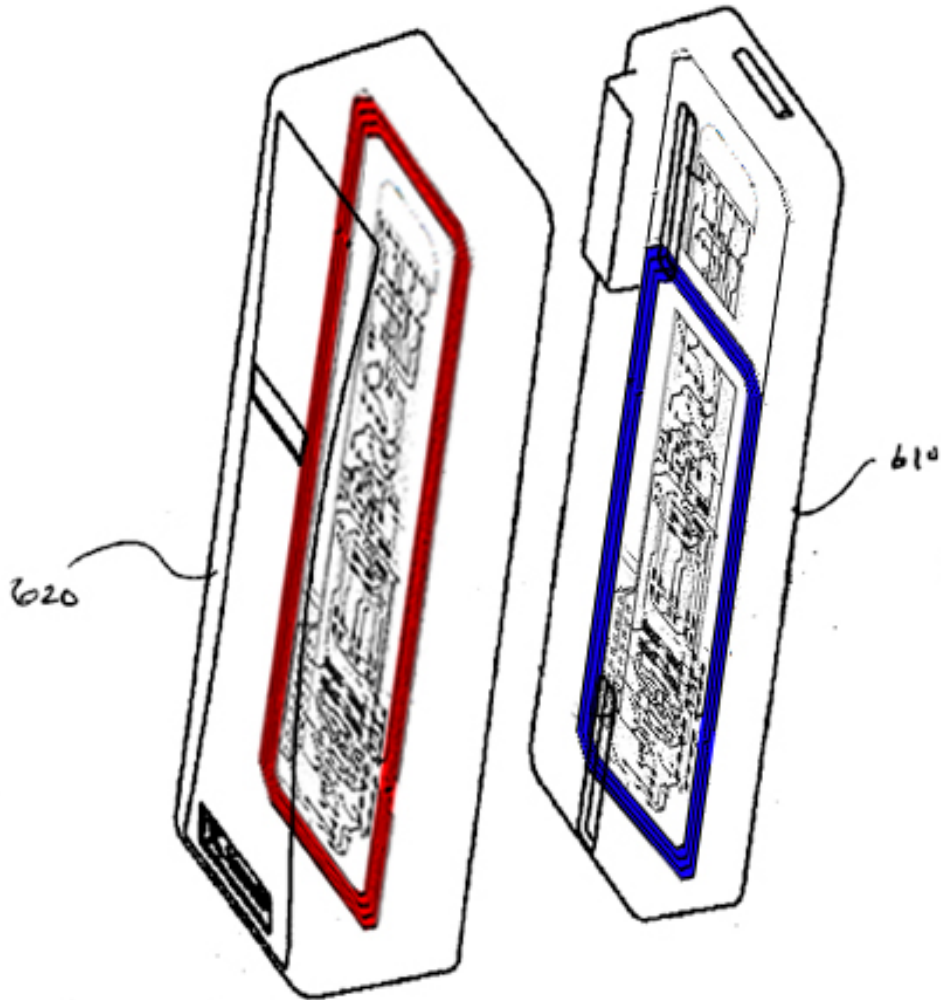
- b. **wherein said first reader antenna has a first area, said second reader antenna has a second area”**

- c. **11[B]: “and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”**

192. *See* Ground 2, Claim 7, *supra* §IX.B.2.b.

6. **Claim 13: “The antenna array of claim 9, wherein said first and second reader antennas are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.”**

193. As discussed above and shown again below, it would have been obvious based on the disclosures of Conlin and Walton to arrange first and second reader antennas such that they are simultaneously overlapping and in an opposing flux arrangement. *See* Ground 1, Claim 5, and Ground 2, Claim 9, *supra*, §§IX.A.8, §IX.B.3.



7. **Claim 22:**

a. **“The antenna array of claim 20,”**

194. As discussed above, Conlin renders obvious claim 20. *Supra*,
§IX.A.14.

- b. wherein said first and second loops have a parallel orientation and are arranged relative one another such that a size of the portion of the first area aligning with the portion of the second area is less than at least one of a size of the first area and a size of the second area.”**

195. As discussed above, a POSITA would have been motivated to arrange the two antennas disclosed in Conlin in a parallel arraignment so that the areas enclosed by the antennas partially, but do not completely, overlap. *See* Claims 1[C], 9[C] and Claim 11[B], *supra* §§IX.A.4.d, IX.B.3.d, IX.B.5.c. This arrangement would result in the first and second loops have a parallel orientation and are arranged relative one another such that a size of the portion of the first area aligning with the portion of the second area is less than at least one of a size of the first area and a size of the second area.

196. A POSITA would have been motivated by Walton’s teachings to arrange the antennas in this manner, as it was well known that such an arrangement would have provided several advantages, including reduced magnetic flux interference, miniaturization and compactness, and the fine-tuning of magnetic flux to specific directions. EX1023, 5:21-43; *see also* EX1008, at 61-85; EX1024, 1:31-40, 2:48-3:2.

197. Indeed, as discussed above with respect to claim 9, it was understood by late 2003 that currents flowing through conductor loops (i.e., an antennas) located in the vicinity of one another may affect the magnetic flux of the loops,

respectively, and thereby impact reader range. *Supra*, § IX.B.3.dEX1023, 5:21-43; *see also* EX1008, §§ 4.1.4 – 4.1.9 (Mutual Inductance through Interrogation field Strength $H_{\min}$), at 61-85; EX1024, 1:31-40, 2:48-3:2. It also was a well-known desire to reduce mutually induced magnetic flux, also referred to as magnetic coupling, so as to reduce any negative impact to reader performance, such as read range and ability to read credentials due to magnetic field interference by one antenna with the magnetic field transmission from the credential, which contains data. EX1023, 2:6-36; *see* EX1008 at 422-36. Thus, a POSITA would have been motivated to implement the antennas disclosed in the '677 application so as to eliminate any negative impact of magnetic flux, which was routinely accomplished by separating conductors in close proximity as much as practicable. *See, e.g.*, EX1008, 64-65; EX1025, at 1-6.

198. In the field of RFID readers, where design considerations dictate a small and compact reader housing, as well as a reader face that allows a user to simply and intuitively approach a reader and physically position a credential card near the reader so that it aligns with the internal antenna(s) and their limited range, it would have been an obvious implementation detail to modify the reader disclosed in the '677 application by allowing for partial antenna overlap (as opposed to complete antenna overlap), which could be achieved by orienting a smaller area formed by one antenna within a larger area of another other antenna or

staggering the overlapping antennas. EX1023, at 5:5-43 Fig. 2A and 2B; EX1024, at 1:31-40, 2:48-3:2 Figs. 1a, 1b, 1c, 1d, 2; EX1008, at 35. Indeed, the ‘862 patent recognizes that such an orientation results in these opposing magnetic flux arrangements. ‘862 Patent, col. 12, ll. 55-58 (Figs. 3A, 3B) and col. 14, ll. 9-30 (Figs. 6A, 6B).

8. Claim 23

a. 23[pre]: “An antenna array for an RFID reader comprising:”

199. *See* Ground 1, Claim 1[pre], *supra* §IX.A.4.a.

b. 23[A]: “a first reader loop antenna having a first loop and tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;”

200. *See* Ground 1, Claim 20[A], *supra* §§IX.A.14.b.

c. 23[B]: “and a second reader loop antenna having a second loop and tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,”

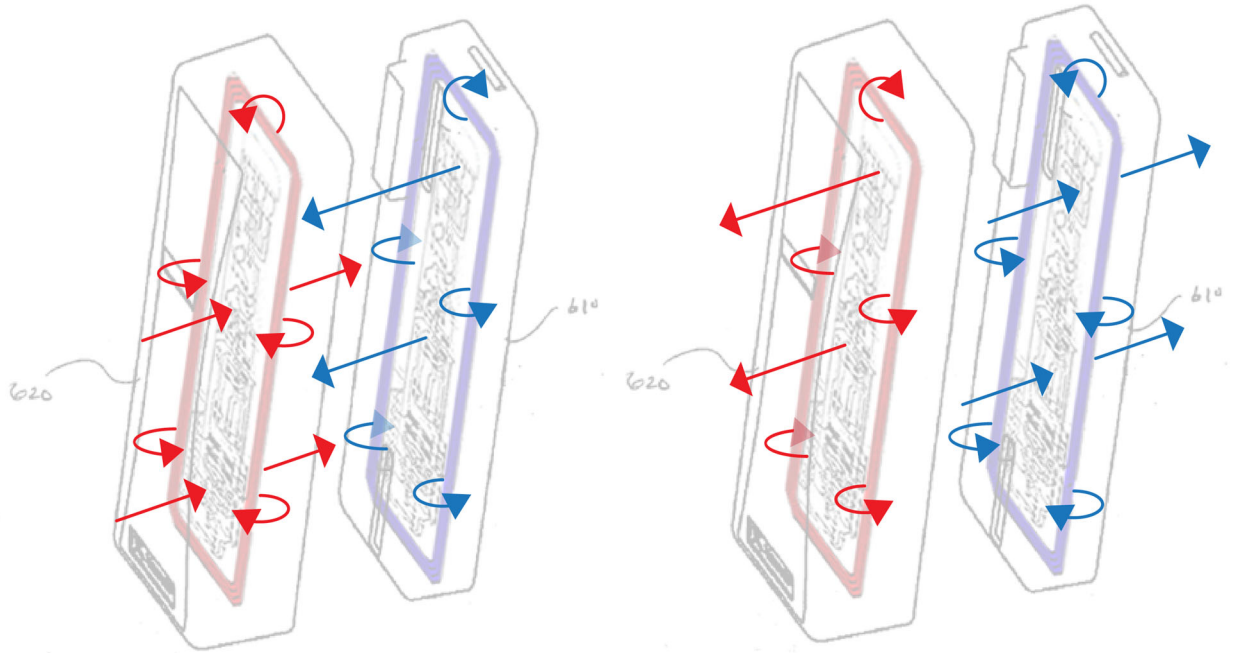
201. *See* Ground 1, Claim 20[B], *supra* §IX.A.14.c.

- d. **23[C]: “wherein said first and second loops are arranged in an opposing magnetic flux arrangement where the direction of magnetic flux created through the first loop is substantially parallel but opposite to the direction of magnetic flux created through the second loop.”**

202. Conlin, through the incorporated '677 application and in view of the background knowledge of the POSITA, renders obvious this limitation.

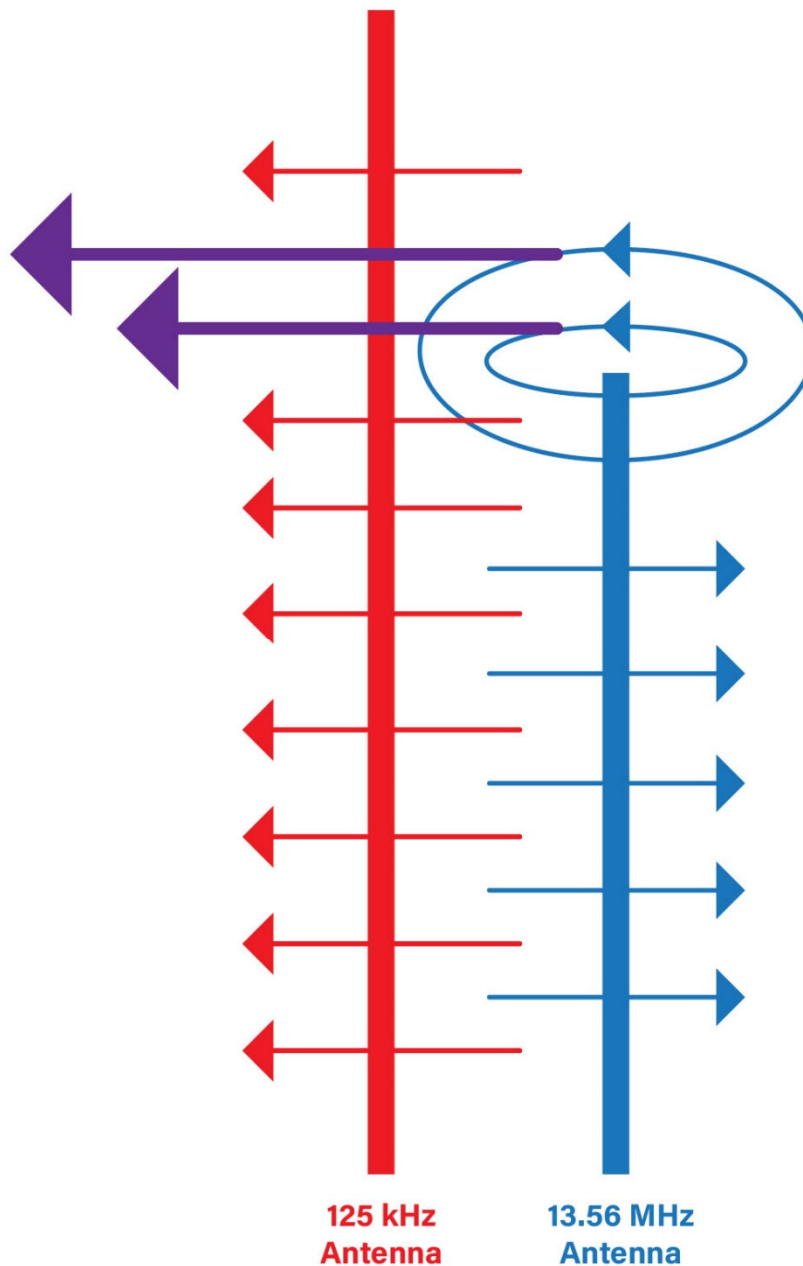
203. As described in §VI.C, *supra*, the direction of magnetic flux around an antenna is dependent on the direction of current in a wire. *See also* EX1023, at 5:15-20. Therefore, for two antenna loops to generate magnetic fields that are parallel but in the opposite directions through their respective loops, the current in one antenna would have to flow in the opposite direction to the current in the other loop.

204. Although the '677 application does not disclose the direction of the magnetic field or of current flow for the 125 kHz or 13.56 MHz antennas, given that there are only two directions a current can flow in a wire, having the currents in the two antenna coils flow in opposing directions is one of two options for the combined reader and the use of either is obvious. For example, as shown below, there are two possible arrangements in which the “the direction of magnetic flux created through the first loop is substantially parallel but opposite to the direction of magnetic flux created through the second loop”:



205. Moreover, in certain circumstances, it is beneficial to arrange two antenna loops “in an opposing magnetic flux arrangement where the direction of magnetic flux created through the first loop is substantially parallel but opposite to the direction of magnetic flux created through the second loop.” As described above with respect to Claim 9[C], a POSITA would have been motivated to arrange the antennas in an opposing magnetic flux arrangement. If the antennas are arranged such that the current in one antenna flows in the opposite direction of the current in the other antenna, then the non-overlapping portion of each antenna experiences *constructive* magnetic interference, which has the positive effect of increasing the magnetic strength, and thus read range, of each antenna at the portion of non-overlap. From the side-profile view below of the arrangement shown in Claim 9[C], the flux that curves around the exterior portion of the blue

13.56 MHz antenna wire runs in the same direction as the magnetic field for the red 125 kHz antenna, which has a magnetic field pointing the other direction. This strengthens the magnetic field of the red antenna, the strengthened portion exemplified in purple.



9. **Claim 24: “The antenna array of claim 23, wherein said first loop has a first area, said second loop has a second area, and said first and second loops are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”**

206. *See Claim 7, supra.*

10. **Claim 26: “The antenna array of claim 23, wherein said first and second loops are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.”**

207. *See Claim 13, supra.*

C. Ground 3: The RFID Handbook in view of the Davis Presentation Renders Obvious Claims 1-6 and 14-21 of the '862 Patent

1. Overview of RFID Handbook

208. I understand that the RFID Handbook, subtitled “Fundamentals and Applications in Contactless Smart Cards and Identification,” was published in 2003. EX1008, at 2. I understand that the RFID Handbook is therefore prior art to the '862 Patent.

209. The RFID Handbook is “aimed at an extremely wide range of readers,” including “students and engineers” and “practitioners.” EX1008, at 3.

210. The RFID Handbook teaches a “practical example” of an RFID system used for access control:

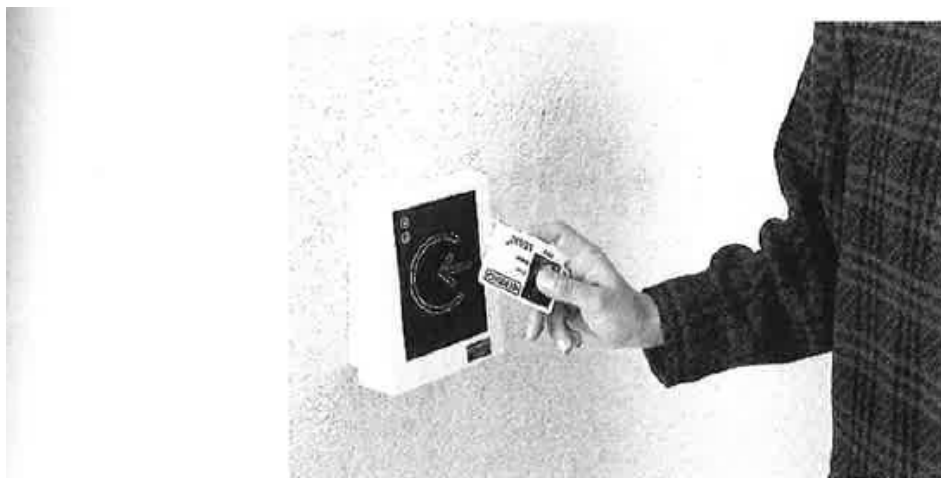


Figure 1.8 RFID reader and contactless smart card in practical use (reproduced by permission of Kaba Benzing GmbH)

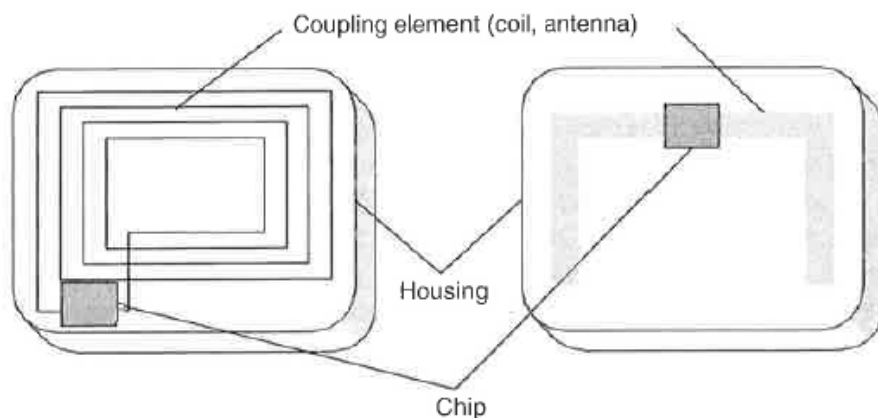


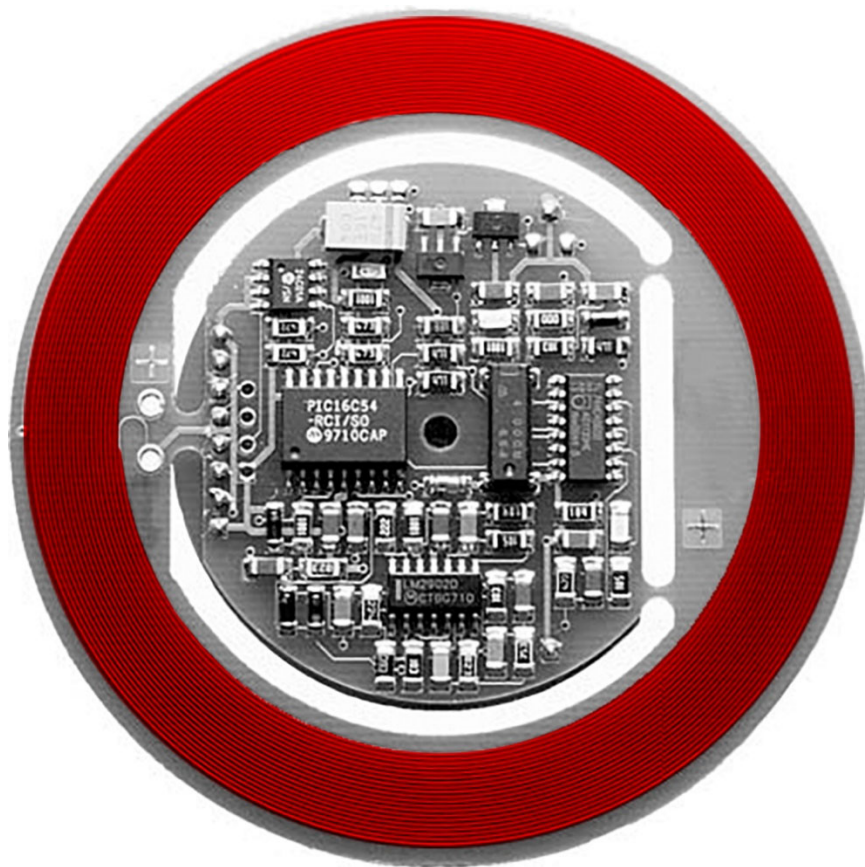
Figure 1.9 Basic layout of the RFID data-carrying device, the transponder. Left, inductively coupled transponder with antenna coil; right, microwave transponder with dipolar antenna

“The transponder is only activated when it is within the interrogation zone of a reader.” *Id.* at 6.

211. The RFID Handbook recognizes that such RFID systems are known. *Id.* at 116 (“Electronic access control systems using data carriers are used to automatically check the *access authorization* of individuals to buildings.”) For contactless access control systems, the RFID Handbook recognizes that the

“antenna can be mounted ‘under plaster,’ where it is completely invisible and protected against vandalism.” *Id.* at 119.

212. Among the extensive disclosures and teachings related to RFID systems in the RFID Handbook are reader antennas for low and high frequency readers. As an example of a low frequency reader, the RFID Handbook describes the “easy-key System” reader, which is used with a transponder in the frequency range <135 kHz and includes an integral antenna on the perimeter of the circuit board of a with number of turns/windings, shown in red below:



Id. at 9 (annotated).

213. The RFID Handbook also describes the high frequency “MIFARE reader,” manufactured by Philips Electronics N.V., which has “an integral antenna for a 13.56 MHz system,” shown in blue, below: *Id.* at 91:



Id. at 92 (annotated).

214. The RFID Handbook, among other things, teaches that “[r]eader antennas in inductively coupled RFID systems generate magnetic flux ϕ , which is used for the power supply of the transponder and for sending messages between the reader and the transponder.” *Id.* at 88.

215. The RFID Handbook is in the same field as the ’862 patent because the RFID Handbook relates to RFID systems used for access control, including components of RFID Readers. *Id.* at 6-11. The RFID Handbook is pertinent to the problems the ’862 patent purportedly addresses because the RFID Handbook

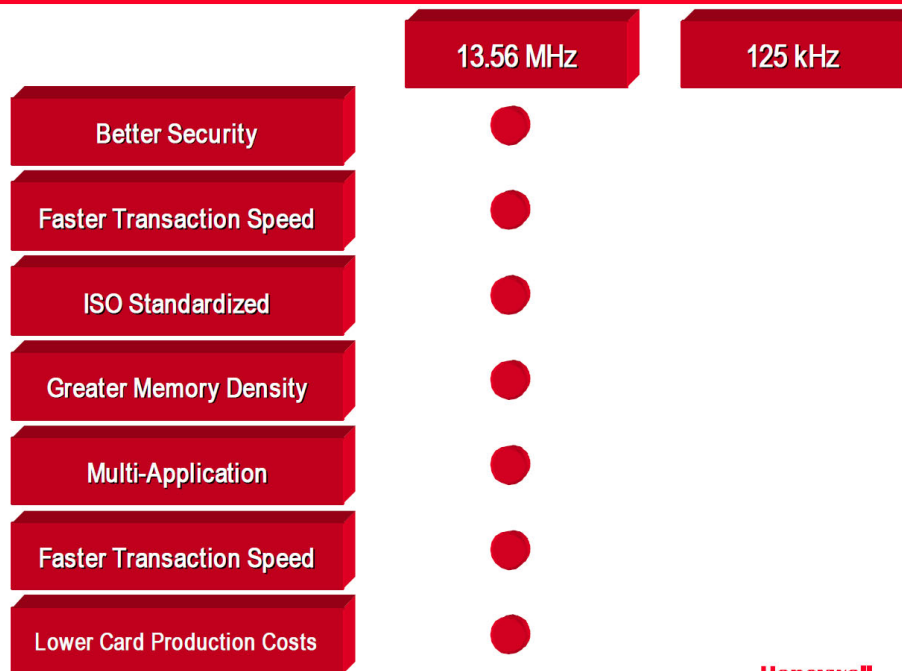
describes arrangements of RFID Reader antennas, the interactions between antennas, and the components of RFID readers. *Id.* at 6-11, 79-97. The RFID Handbook therefore is analogous art to the '862 patent.

2. Overview of Davis Presentation

216. The Davis Presentation is a published presentation entitled “Migration Strategies (With an Emphasis On Moving from 125 kHz Prox to 13.56 MHz Contactless Smart Card Technology).” EX1011. The Davis Presentation indicates that it was presented at a “Workshop on Storage & Processor Card-Based Technologies” on July 8, 2003. *Id.* at 2, footer. I understand that the Davis Presentation is prior art to the '862 Patent.

217. The Davis Presentation provides an overview on two known types of RFID systems and transponders: (1) those operating at 125 kHz and comprising “prox” card transponders; and (2) those operating at 13.56 MHz and comprising “smart” card transponders. (EX1011 at 4-5.) The Davis Presentation further describes the benefits 13.56 MHz systems provide over 125 kHz systems:

Why Migrate to Contactless Smart Cards?



Workshop on Storage & Processor Card-Based Technologies
July 8th, 2003

Honeywell
Contactless Smart Card Integration, page 7

Why Migrate? (cont.)

- Added Benefits With No Increase in Price
- Increased Security
- Ability to use same card for additional applications:
 - Biometrics: Carry multiple templates on card
 - Logical Access
 - ID: Carry Tamperproof Digital Photographs
 - Portable Database: Encrypted Information for authentication or emergencies
- Interoperability
- Future Growth

Workshop on Storage & Processor Card-Based Technologies
July 8th, 2003

Honeywell
Contactless Smart Card Integration, page 8

Why Migrate (cont.)

- **International Standardization**
 - **Current 125 KHz Prox Technology**
 - ◆ No ISO existing or planned standardization
 - ◆ Proprietary
 - HID, Motorola, AWID, Casi-Rusco, etc.
 - **New 13.56 MHz Contactless Smart Cards**
 - ◆ Standards DO exist
 - ISO 14443A, 14443B, 15693
 - ◆ Open standards with interoperability encourages broad supplier support and customer acceptance
 - ◆ Open standards can increase market size driving prices down
 - ◆ Facilitates interoperability between vendors and applications
 - ◆ Helps to drive costs down
 - ◆ Helps to eliminate obsolescence

Workshop on Storage & Processor Card-Based Technologies
July 8th, 2003

Honeywell
Contactless Smart Card Integration, page 11

(*Id.* at 7-8, 11.)

218. The Davis Presentation also describes benefits of moving to smart cards as including multi-application support, wherein the larger data memory in each smart (13.56 MHz) card permits the card to be used for multiple applications, as opposed to the limited application uses available due to the limited memory on prox (125 kHz) cards. *Id.* at 4-5, 9-10. Thus, the Davis Presentation teaches the benefits of migrating from a low-frequency, prox card system to a high-frequency, smart card system.

219. The Davis Presentation sets out the three primary ways migration could be achieved and the reasons that migration strategy would be used. For example, the Davis Presentation discusses the use of a “multi-technology card,” which provides the greater security, but at a greater cost and with operational setbacks relating to “Reduced field-reliability due to multiple technologies.” EX1011, at 14-16. Likewise, the Davis Presentation discloses using an “existing card w/smart card sticker,” which has a much lower cost but comes with several disadvantages, including a reduced read range, issues regarding the placement of the sticker “so card still works in existing readers (like magstripe),” security issues if the sticker is removed from a card, and limited ability to use at all organizations. *Id.* at 19, *see id.* at 17-19.

220. Finally, the Davis Presentation describes multi-technology readers as a solution to migration. The Davis Presentation indicates that multi-technology readers may aid with migrating between “Prox and Contactless Smart Card” systems, as well as other data transfer technologies and over multiple protocols and interfaces:

Migration Strategies: Use Multi-Technology Readers

- **Multi-technology readers are capable of reading two different technologies**
 - Prox and Contactless Smart Card
 - Contact and Contactless Smart Card
 - Prox and Magnetic Stripe
- **Multi-technology readers may have multiple output protocols and interfaces**
 - Wiegand
 - Clock & Data
 - RS232
 - Etc.

Workshop on Storage & Processor Card-Based Technologies
July 8th, 2003

Honeywell
Contactless Smart Card Integration, page 21

221. The Davis Presentation discloses that multi-technology readers permit no “changes to cards” or “card rebadging,” thereby avoiding the “obstacle” of “[r]e-badging thousands of employees” and complications about “[w]hat to do during interim period” of removing of old reader system and implementation of new reader system, although at a higher reader cost. (*Id.* at 3, 22.)

222. The Davis Presentation is in the same field as the ’862 patent because the Davis Presentation relates to the use of RFID systems used for access control, including the comparative advantages and disadvantages of using credentials that operate at 125 kHz and 13.56 MHz, reasons to migrate from 125 kHz systems to

13.56 MHz systems, and methods to achieve the migration. (EX1011, at 1, 3-23.)

The Davis Presentation is pertinent to the problems the '862 patent purportedly addresses because the Davis Presentation describes motivations to integrate multi-technology and multi-frequency components into a single RFID reader. (*Id.* at 20-22.) The Davis Presentation therefore is analogous art to the '862 patent.

3. Claim 1

a. 1[pre]: “An antenna array for an RFID reader comprising:”

223. To the extent the preamble is limiting, the RFID Handbook discloses this limitation. The RFID Handbook discloses the easy-key System reader, which communicates in the frequency range under 135 kHz and includes an integral antenna on the perimeter of the circuit board. EX1008, at 9. The RFID Handbook also discloses the Philips MIFARE reader, also “with integral antenna.” *Id.* at 92. As explained below, it would have been obvious to integrate a low frequency antenna and reader electronics into the Philips MIFARE reader such that the reader comprises an antenna array. *See* claim 1[C], *infra*. The Davis Presentation also discloses low-frequency RFID readers. *See* EX1011, at 1, 5-11, 21-22; *see also supra* §IX.C.3.

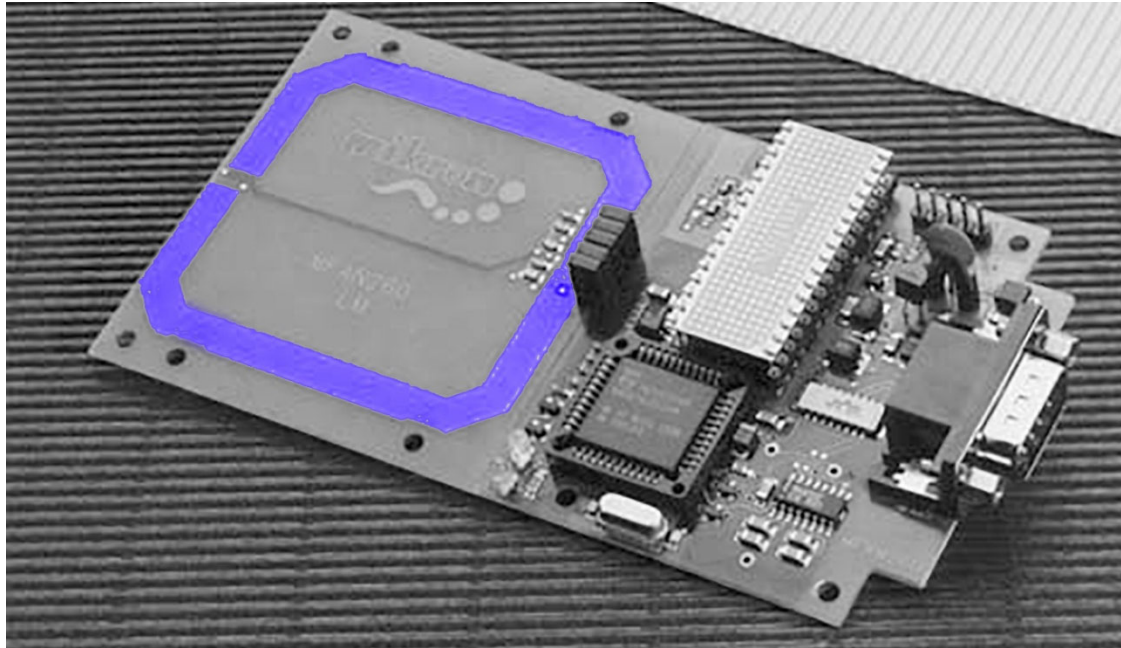
- b. 1[A]: “a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency”**

224. The RFID Handbook discloses multiple low frequency readers containing antennas that “enable[e] data communication with a first transponder transmitting data signals at said first low carrier frequency.” For example, the RFID Handbook discloses the easy-key reader, which comprises a reader antenna tuned to operate at a first low carrier frequency (<135 kHz). EX1008 at 9. The RFID Handbook describes the easy-key reader as a “[r]eader for inductively coupled transponder in the frequency range <135 kHz with integral antenna.” *Id.* A POSITA would have understood the disclosure of inductive coupling to the transponder to enable the communication of data with the transponder at the low carrier frequency. EX1008, at 7-9; *see also id.* at 79-90. The Davis Presentation also discloses low-frequency RFID readers. See EX1011, at 1, 5-11, 21-22; *see also supra* §IX.C.2.

- c. 1[B]: “and a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency”**

225. The MIFARE reader disclosed in the RFID Handbook comprises a reader antenna tuned to operate at a high carrier frequency (13.56 MHz) that is

different from the low carrier frequency. EX1008, at 92. As shown below in blue, “Figure 11.19 shows a reader with an integral antenna for a 13.56 MHz system.”:



EX1008, at 92.

226. Moreover, a POSITA would have understood that the RFID Handbook’s disclosure of “a reader with an integral antenna for a 13.56 MHz system” discloses the transfer of data between the transponder and the reader. EX1008, at 7-9. For example, the RFID Handbook discloses an HF interface for the Philips MIFARE Reader, which is responsible for “modulation of the transmission signal to send data to the transponder” and “reception and demodulation of HF signals transmitted by a transponder,” discloses the enablement of the transmissions of data signals at 13.56 MHz between the MIFARE reader and a transponder tuned to operate at that frequency.

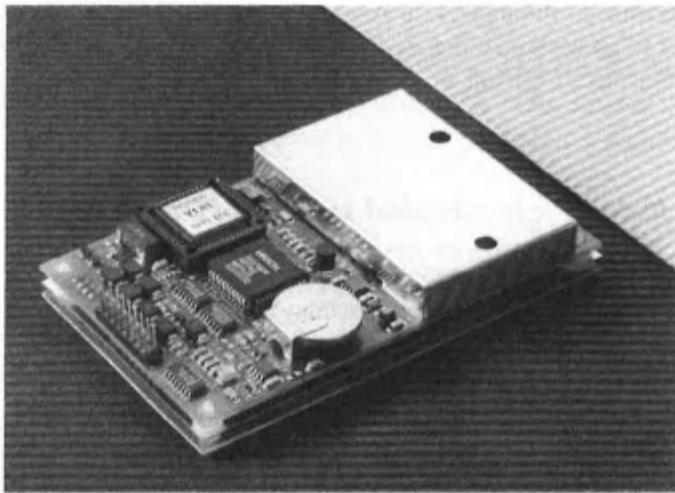


Figure 11.3 Example of a reader. The two functional blocks, HF interface and control system, can be clearly differentiated (MIFARE® reader, reproduced by permission of Philips Electronics N.V.)

EX1008, at 80, 91-92. Moreover, readers that operate at 13.56 MHz and generate signals and receive signals from transponders were known in the art. *See, e.g.*, EX1009, at 1-2.

227. In light of the migration from 125 kHz systems to 13.56 MHz systems described by the Davis Presentation, a POSITA would have been motivated to first look to available readers in order to find a suitable reader that could be combined with 125 kHz reading capabilities. *See supra* §§IX.C.2; IX.C.3.b. A POSITA would have known that the flat MIFARE circuit board provides a suitable starting point of the previously-existing readers. *See* EX1008, at 80. Because the MIFARE reader places its antenna and electronics on one side of a circuit board, this provides the other side of the circuit board to incorporate a low frequency antenna. *See id.* Moreover, with space remaining on the top surface of the MIFARE circuit

board in the area encircled by the 13.56 MHz antenna, this provides space to place any further 125 kHz reader electronics. Therefore, a POSITA would have applied the teachings from the Davis Presentation to the MIFARE reader circuit board by incorporating a 125 kHz antenna on the MIFARE circuit board.

d. 1[C]: “wherein the first and second antennas are oriented along axes that are substantially parallel to one another.”

228. A POSITA would have been motivated by the teachings of the Davis Presentation to integrate a low frequency antenna and associated circuitry such as that described in the RFID Handbook with respect to the easy-key reader, into a high-frequency reader such as the MIFARE reader, as also taught by the RFID Handbook, such that the reader could operate at both low and high frequencies.

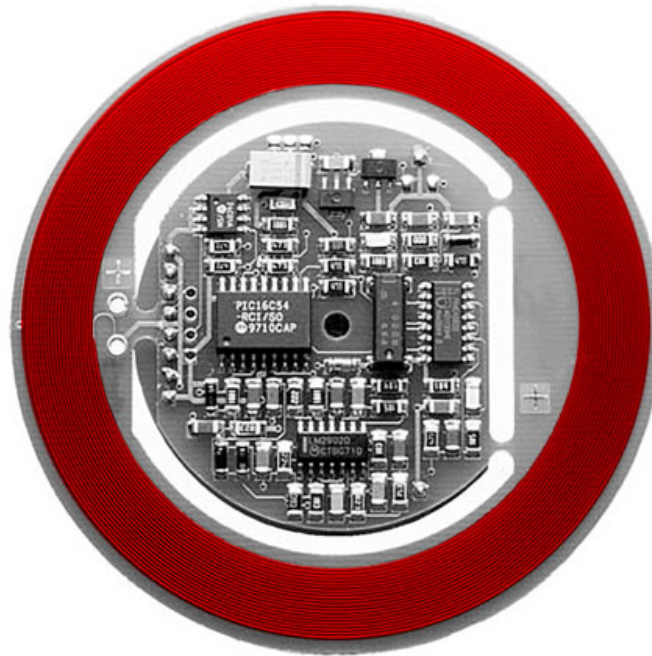
229. As described above, a POSITA would have known that incorporating both high-frequency and low-frequency communication capabilities into a single reader would provide numerous advantages, including enabling the continued use of legacy low-frequency prox cards while migrating to newer high-frequency smart cards. (*Supra*, §VI.) For example, the Davis Presentation explicitly identifies using multi-frequency readers as a known solution to accomplish migration from legacy to newer cards. (EX1011, at 12, 20-23.) While the Davis Presentation notes certain drawbacks such as the high cost and limited availability of such readers, these are practical considerations depending on the position of the

company undergoing migration, and do not reflect any shortcomings with respect to the technology itself. Moreover, the Davis Presentation teaches that there were only a limited number of options for migration, and that using a multi-frequency reader was a viable option that would yield known advantages. EX1011, at 22-23 (describing advantages of multi-frequency readers and viability as a migration solution); *see also* EX1010, at 34 (“[D]epending on the number of cards and readers involved, there are migration scenarios in which readers supporting a variety of technologies are practical.”).)

230. Similar combinations have been seen in related radio-frequency technologies. For example, Howell (EX1029) teaches integrating multiple RF technologies into a single reader in order to address the lack of “common carrier modulation and data transmission system agreed [on] between manufacturers for [] transponders” and thereby incompatibility between “the systems chosen by different manufacturers of tags and readers.” EX1029, at 1 (57); 4:3-7; *see also id.* at 44:3-14; 50:9-19.

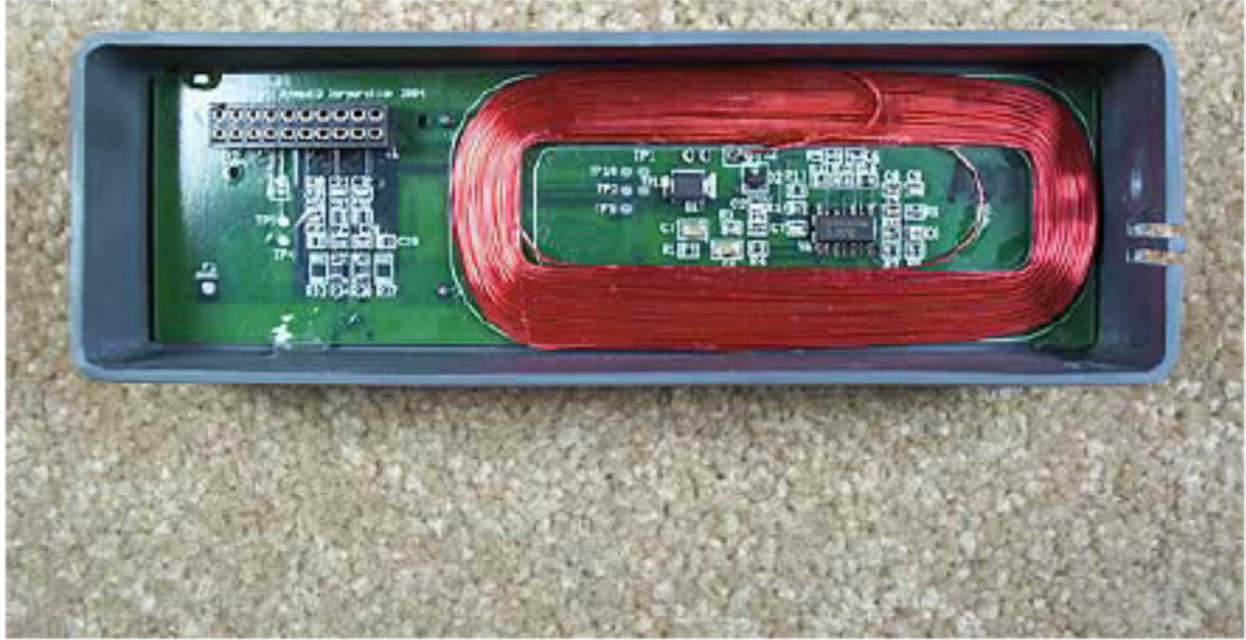
231. Indeed, by 2003, it would have been obvious to incorporate a low-frequency antenna into a high-frequency reader such as the MIFARE disclosed in the RFID Handbook in one of several different ways. One way would be to embed the low-frequency antenna along the perimeter of the underside of the Philips MIFARE. The underside would have been used because the top side surface of the

Philips MIFARE circuit board is already filled, and disposing the antenna around the existing 13.56 MHz antenna would have added additional size to the board, which a POSITA would have been motivated to keep as small as practicable. The easy-key System Reader discloses an example of what an embedded antenna for use with a similar frequency to 125 kHz (<135 kHz) would look like:



EX1008, at 9; *see also id.* at 99.

232. Another known way to incorporate a low frequency antenna would have been to mount a wound antenna above the circuit board. An example of this approach is the red antenna located in the XceedID XF1100 Reader:

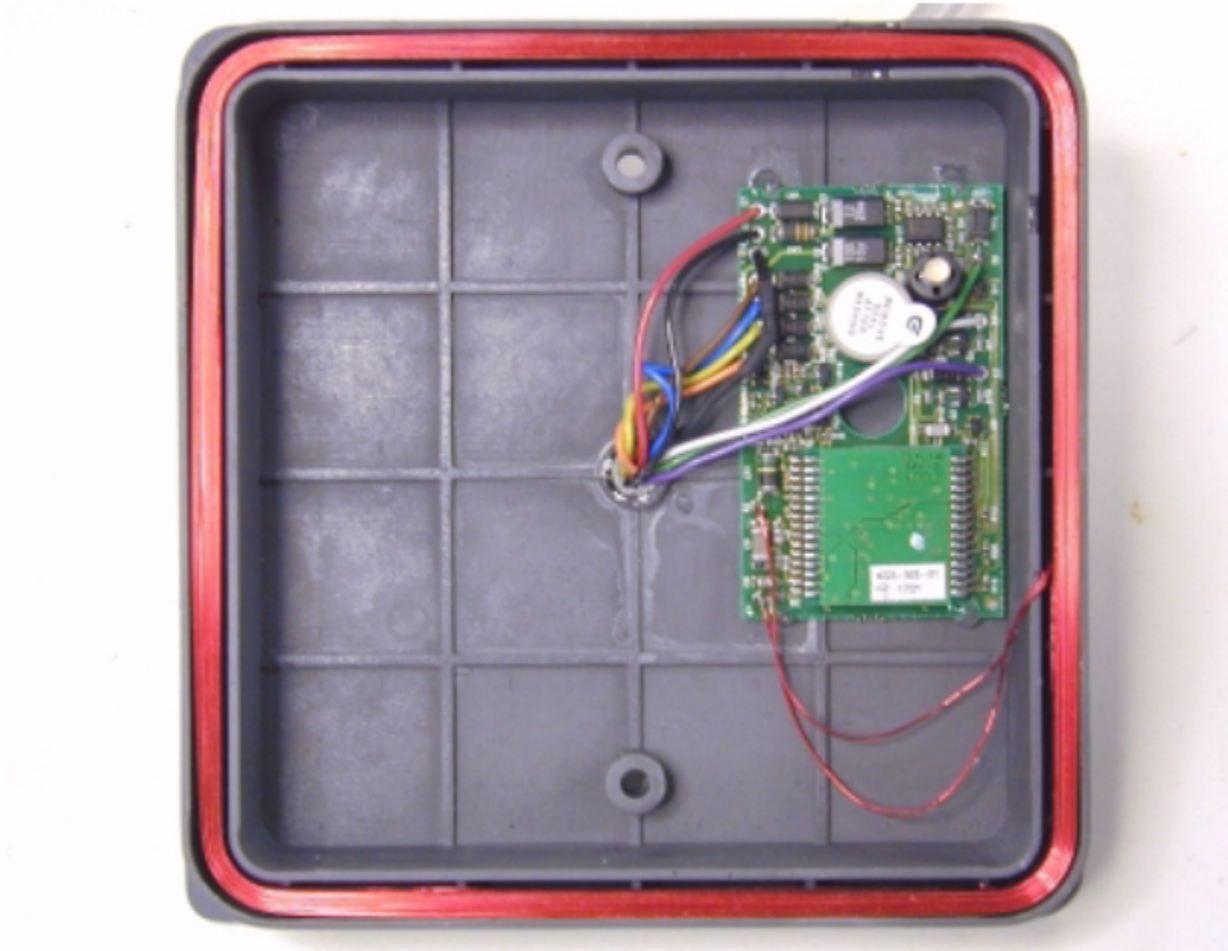


Antenna PCB Top

EX1027, at 3; *see also* EX1008, at 99.

233. A third method that would have been known to a POSITA by 2003 would be to attach the wound 125 kHz frequency antenna along the interior perimeter of the housing for the MIFARE reader antenna. This can be seen, for example, in the Thinline II Reader on sale as of 2003:

**5455/8B (5455-310) ProxPro II
Photograph
Internal View**



EX1012; *see also* EX1029 at 28, ll. 14-19; EX1008, at 99.

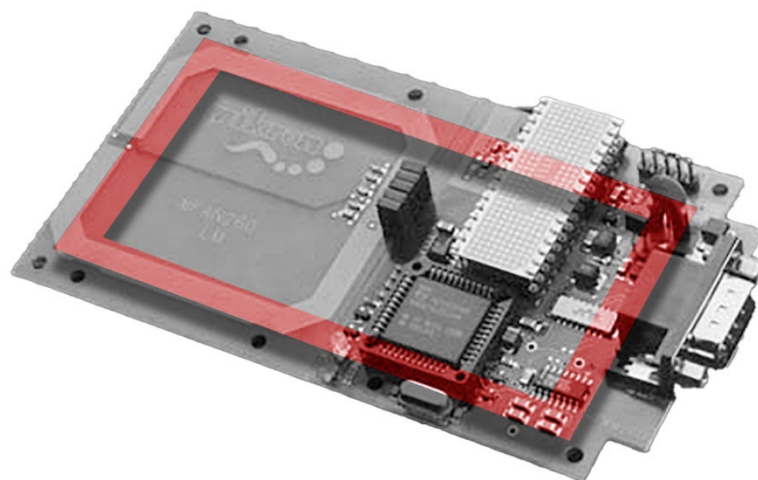
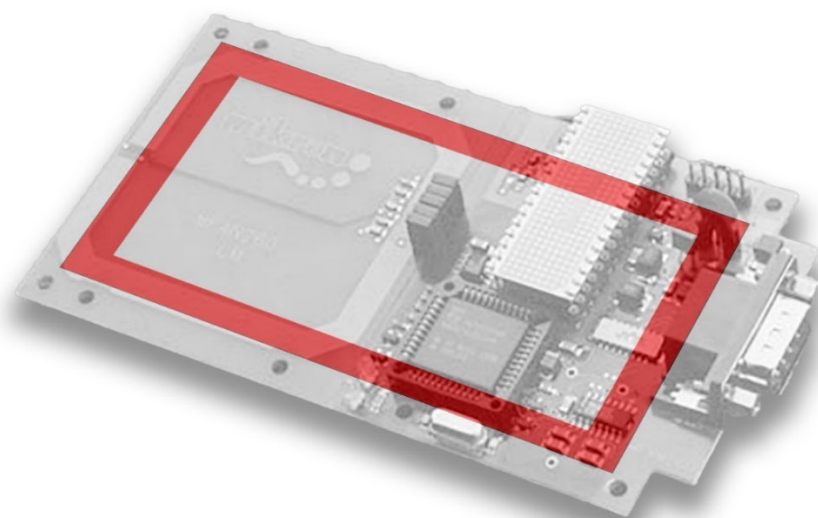
234. A POSITA would have been motivated to place the low-frequency antenna along the perimeter because these arrangements give the antenna the largest diameter possible within the limited housing space, and a POSITA would have known that larger antenna diameters increase antenna read range. EX1008, at 15-23. However, a POSITA would have known that each of these three methods of

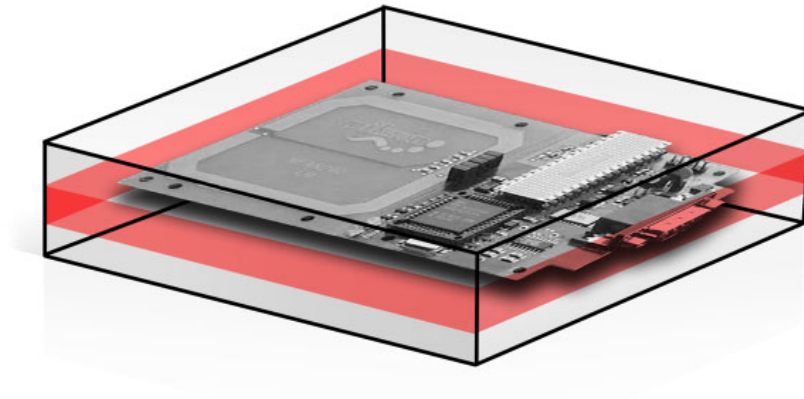
incorporating the 125 kHz antenna minimally affects the size of the reader, thus enabling a reader that can support new data transfer protocols as well as legacy cards. Any of these combination approaches would provide the benefit of being a compact way to create a multi-frequency reader. The housing for this combined reader wouldn't necessarily be any larger than the housing for the Philips MIFARE reader—integrating the antenna on the other side of the PCB would not add any thickness to the reader; attaching the antenna to the top of the PCB would only add minimal height to the reader housing, given that other components project from the top surface of the reader antenna, and attaching the antenna to the housing would not add any size to the reader.

235. Incorporating a 125 kHz antenna and the electronics for that antenna by any of these approaches would have been within the skill of the POSITA before 2003. To operate the 125 kHz antenna, only a signal generator for the 125 kHz antenna and other conventional receiver electronics would have to be incorporated onto the MIFARE circuit board, which would be connected to the microcontroller and power source already incorporated on the MIFARE reader board. The top surface of the MIFARE printed circuit board contains additional space which may contain the other signal generator and receiver electronics, such as the area enclosed by the loop of the 13.56 reader antenna. It is conventional to place electronics on the center of a printed circuit board and surround the electronics

with the antenna. *See* EX1008, at 9; EX1007, at 35-36, 43-44; EX1015, at 1, 3; EX1016, at 1-7. Designing a printed circuit board to place these conventional features on the board was within the skill of the POSITA by 2003. Indeed, a POSITA would have taken several classes in circuit design, including in radio-frequency circuit design. Further, a POSITA would have been able to design, test, and adjust the placement of various electrical components as needed in the combined reader through the circuit board and antenna modeling and simulation programs available at the time, as well as through physical prototypes.

236. In any of these obvious ways to integrate low-frequency reader capabilities into the Philips MIFARE reader, the low-frequency antenna is oriented along an axis that is parallel to the axis along which the 13.56 MHz antenna is oriented, as shown below: (1) embedded low frequency antenna (shown from a top-down perspective through the MIFARE circuit board); (2) a low frequency antenna attached to the top or bottom surface of the circuit board; and (3) a low frequency antenna disposed around the perimeter of the housing:





237. A POSITA would have known that while any of these ways of implementing the MIFARE reader with a low frequency antenna would have provided advantages and disadvantages, for most applications it would be preferable to embed the low-frequency antenna along the perimeter of the underside of the circuit board, as this implementation is the most direct and straightforward. For example, this implementation provides the simplest means of assembly, by merely inserting a circuit board containing all electronics into a housing, rather than having to take multiple steps to assemble the low frequency antenna into the housing first and then add the MIFARE circuit board, or to have to use higher levels of care when placing the reader in a housing if the antenna is placed on top of the circuit board so as to avoid the housing coming into contact with the attached antenna and disturbing it or the electronics. Moreover, an

embedded antenna does not run the risk of being knocked out of place because it is included in the circuit board, not just attached. Finally, the assembly of the circuit board itself could take place in fewer steps, with the low frequency antenna being embedded on the circuit board in the same phase of production as the high frequency antenna, rather than the antenna being placed on the circuit board or in the housing at an additional step.

238. Therefore, when implemented on the MIFARE circuit board, the 125 kHz antenna (red) and the 13.56 MHz antenna (blue) would be partially overlapping on opposite sides of the circuit board—parallel planes.



4. Claim 2: “The antenna array of claim 1, wherein said first low carrier frequency is nominally 125 kHz.”

239. The RFID Handbook discloses this limitation. *See* Claim 1[A], *supra* §§VIII.; EX1008, at 49-51, 53-55, , 87.

5. Claim 3: “The antenna array of claim 2, wherein said second high carrier frequency is about 13.56 MHz.”

240. The RFID Handbook discloses this limitation. *See* Claim 1[B], *supra* §IX.C.3.c.

6. Claim 4: “The antenna array of claim 1, further comprising a reader housing containing said first and second antennas.”

241. The RFID Handbook discloses this limitation. Although the RFID Handbook does not disclose the precise housing containing the MIFARE circuit board, it is exceedingly obvious that the Philips MIFARE reader alone and in combination with a 125 kHz frequency reader antenna as described in Claim 1 would include a housing to protect the reader antennas and sensitive electronic components from exposure to the elements, vandalism, or other wear. (*See, e.g.*, EX1008, at 119; EX1009; EX1033.) For example, the RFID Handbook discloses multiple housings for RFID Readers, including the following:

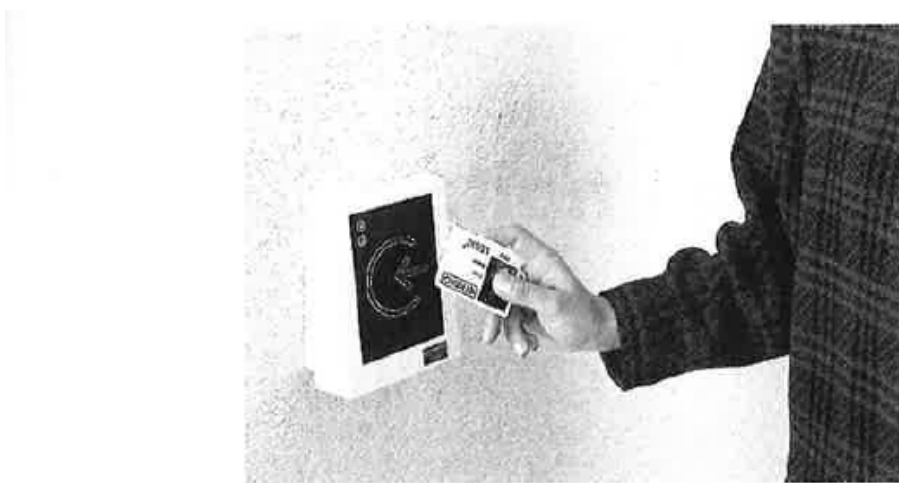


Figure 1.8 RFID reader and contactless smart card in practical use (reproduced by permission of Kaba Benzing GmbH)

EX1008, at 6; *see also id.* at 104-135.

242. Moreover, it was within the skill of a POSITA to design a housing that would house both the Philips MIFARE circuit board, along with the

electronics and antennas described with reference to the 125 kHz carrier frequency antennas Claim 1. For example, a POSITA would have been able to select the housing design material such that the reader magnetic fields are able to penetrate the housing to read credentials. A POSITA could have selected a material and tested its suitability through the use of an electromagnetic simulation tool and an AutoCAD tool. Generally, a POSITA would have designed a reader housing to be rugged and as minimal as possible to house the electronics. The closer the housing to the readers, the closer a credential may be placed to the antenna, which provides superior reading capabilities under the condition that the placement of the housing is not too close disturbing the transmitted field. EX1008, at 14-35; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2.

7. Claim 5

a. 5[pre]: “An antenna array for an RFID reader comprising:”

243. *See* Claim 1[pre], *supra* § IX.C.3.a.

b. 5[A]: “a first reader antenna tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency”

244. *See* Claim 1[A], *supra* § IX.C.3.b.

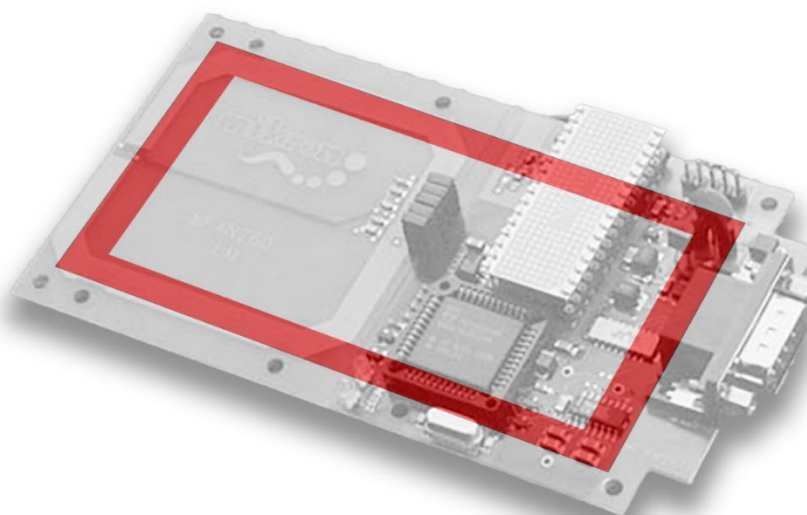
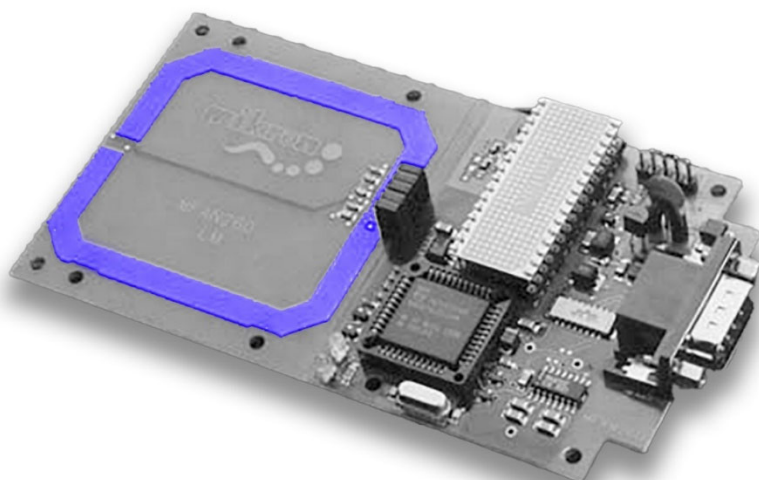
- c. **5[B]: “and a second reader antenna tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency”**

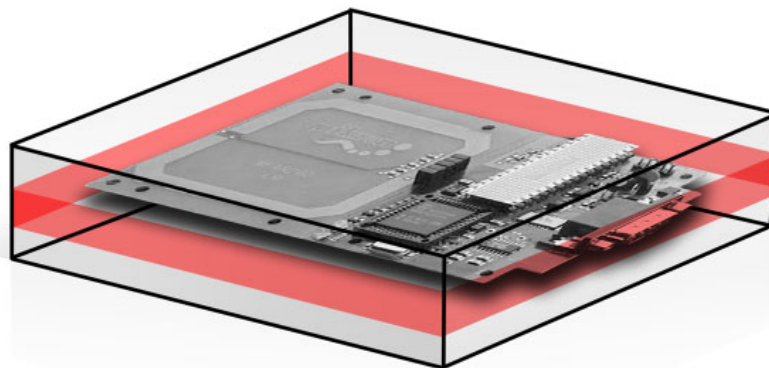
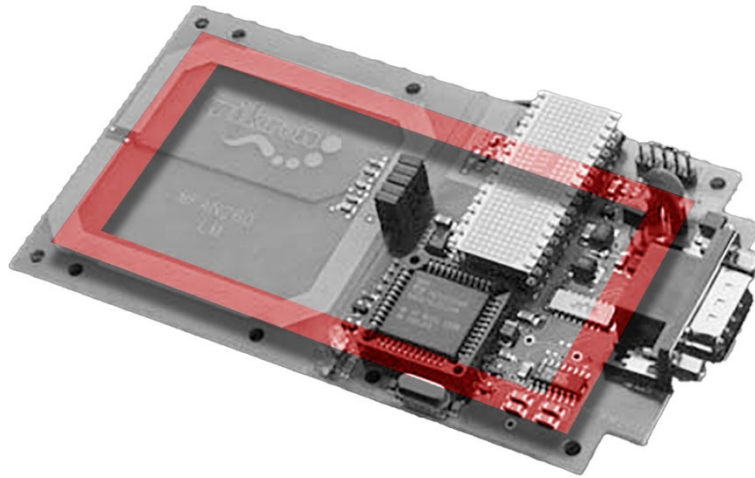
245. See Claim 1[B], *supra* § IX.C.3.c.

- d. **5[C]: “wherein said first and second antennas are arranged in at least a partially overlapping arrangement on proximate adjacent planes.”**

246. The RFID Handbook teaches this limitation.

247. As described under Claim 1[C], implementing the MIFARE reader to include a low frequency antenna reader could advantageously be done by embedding the antenna on the underside of the printed circuit board, attaching the coil on top of one of the other sides of the printed circuit board, or attaching the loop antenna around the edge to the reader housing. *Supra*, §IX.C.1.d. Each of these limited ways to incorporate a low-frequency antenna results in a partially overlapping antennas. For example, as shown below, the 13.56 MHz antenna (blue) would at least partially overlap the low frequency antenna (red):





248. Further and as shown in the above figures, each of these ways to arrange the low-frequency antenna would place the two antennas “on proximate adjacent planes.” For example, if the low-frequency antenna is embedded on the opposite side of the MIFARE reader antenna, the two antennas would be on proximate planes located on either side of the PCB, as shown below:



249. If the low-frequency antenna is attached above or below the MIFARE reader antenna, the plane on which the low-frequency antenna sits would be just off the top or bottom surfaces of the PCB. Finally, if the low-frequency antenna is integrated on to the housing for the reader, this would also place the two antenna planes in a proximate arrangement.

8. Claim 6: “The antenna array of claim 5, further comprising a reader housing containing said first and second antennas.”

250. See Claim 4, *supra* § IX.C.6.

9. Claim 14

a. 14[pre]: “An RFID reader for an RFID system comprising:”

251. The RFID Handbook discloses an RFID Reader. See Claim 1, *supra* §IX.C.3. Relating to the “RFID System,” the RFID Handbook discloses that the Philips MIFARE is an “Inductive System[,],” which a POSITA would have known would have been with inductive transponders as part of an RFID system. EX1008, at 92.

252. The RFID Handbook and Davis presentation also disclose RFID systems for low frequency readers. For example, the RFID Handbook disclose the

easy-key system reader, which is used “for inductively coupled transponder in the frequency range <135 kHz.” EX1008, at 9. Also disclosed is the U2270B reader, which operates between the frequency range 100-150 kHz, typically 125 kHz, and may be used to read transponders installed in vehicles, such as immobilization systems. *Id.* at 86-88. The Davis presentation further discloses RFID systems for low frequency and multi-frequency (which includes low frequency) RFID systems. EX1011, at 4-22; EX1008, at 9, 79-90.

- b. 14[A]: “an antenna array including a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency.”**

253. *See* Claim 1[A], *supra* § IX.C.3.b. The Philips MIFARE-125 kHz reader combination teach an antenna array. *See* claim 14[C], *infra*.

- c. 14[B]: “and a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,”**

254. *See* Claim 1[B], *supra* § IX.C.3.c.

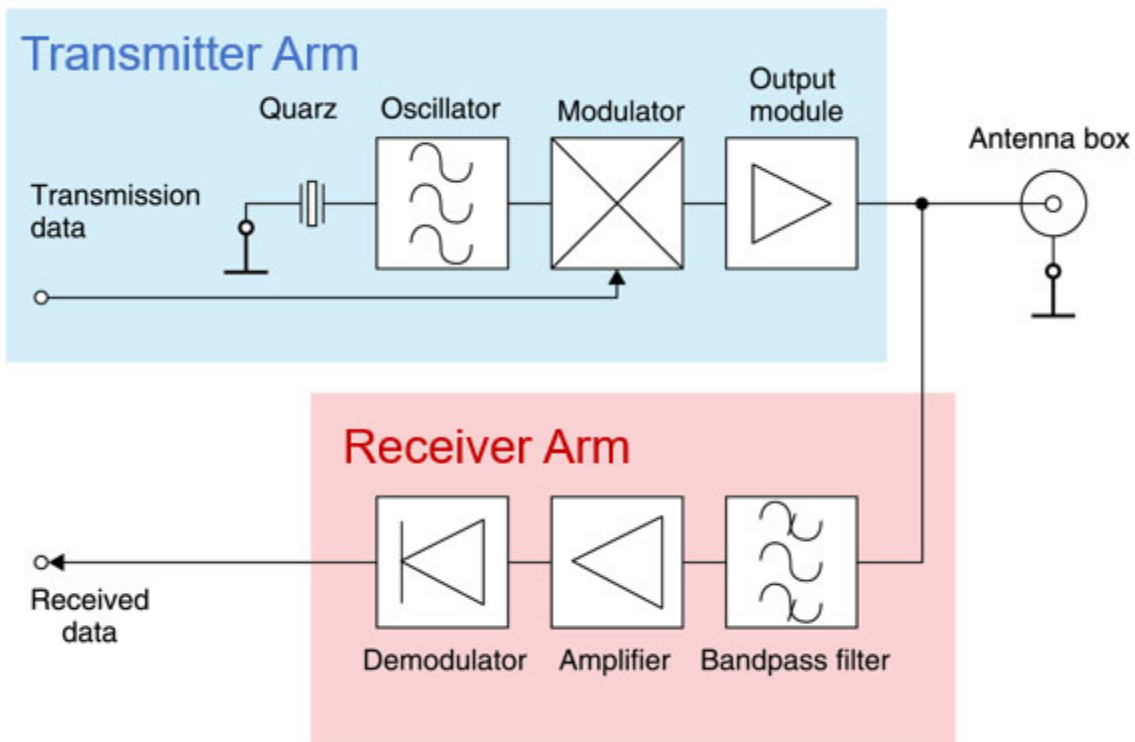
- d. 14[C]: “wherein the first and second antennas are oriented along axes that are substantially parallel to one another”**

255. *See* Claim 1[C], *supra* § IX.C.3.d.

e. **14[D]: “and a signal generator coupled with said first and second reader antennas.”**

256. The RFID Handbook also discloses the use of a signal generator coupled with low-frequency and high-frequency antennas. For the Philips MIFARE readers to utilize its integral antennas and actually read transponders, the antenna would have to be connected to a signal generator. EX1008, at 80-81. Likewise, in order for any 13.56 MHz or <135 kHz frequency reader known in the prior art to the POSITA to operate, including the low-frequency reader antenna that a POSITA would have integrated into the PHILIPS MIFARE system, it would have to be connected to a signal generator.

257. Indeed, the RFID Handbook describes several processes for signal generation. See EX1008, at 80-85; *see also id.* at 137-142. “Readers in **all systems**” include an “*HF interface*, consisting of a **transmitter** and receiver.” *Id.* at 79 (bolded emphasis added); *see also id.* at 80 (showing the HF interface for the Philips MIFARE reader). In the HF interface, “Data transmitted to the transponder travels through the *transmitter arm*.” EX1008, at 80-81 (emphasis original). The “signal of the required operating frequency, i.e. <135 kHz or 13.56 MHz [or any other frequency], is generated in the transmitter arm by a stable (frequency) quartz oscillator.” EX1008, at 81. Figure 11.4 of the RFID Handbook further displays a “[b]lock diagram of an HF interface for an indicatively coupled RFID system,” including the transmitter arm:



EX1008, at 81 (annotated).

10. **Claim 15:** “The RFID reader of claim 14, wherein said signal generator is an integrated signal generator including integral means for generating signals for transmission from said first and second reader antennas.”

258. It would have been an obvious modification of the Philips MIFARE-125 kHz combined reader to utilize an integrated signal generator.

259. Integrated signal generators were known in the art by late 2003; indeed, the '862 patent notes that signal generators are “conventional.” EX1001, 6:21-27; *see also* EX1008, EX1020; EX1021.

260. For example, the RFID Handbook discloses the block diagram of the U2270B reader integrated circuit (“IC”) produced by TEMIC Semiconductor

GmbH. EX1008, at 87-88; *see also* EX1020. “The on-chip oscillator generates the operating frequency in the range of 100-150 kHz. The precise frequency is adjusted by an external resistor at pin R_F .” EX1008, at 88; EX1020, at 1.

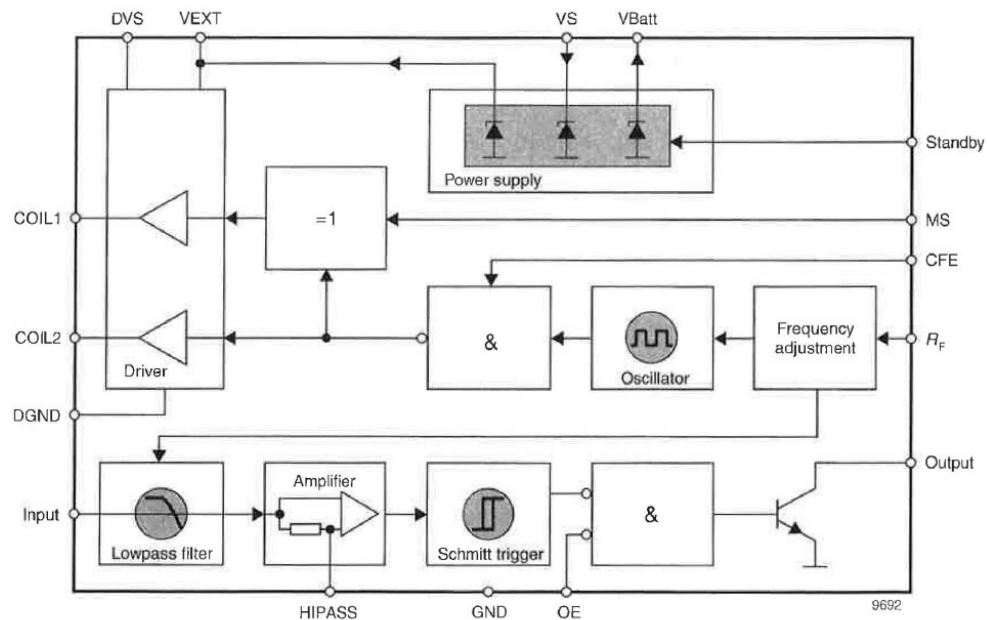


Figure 11.12 Block diagram of the reader IC U2270B. The transmitter arm consists of an oscillator and driver to supply the antenna coil. The receiver arm consists of filter, amplifier and a Schmitt trigger (reproduced by permission of TEMIC Semiconductor GmbH, Heilbronn)

EX. 1008, at 87, EX1020, at 2. The RFID Handbook discloses a single Driver, which provides the appropriate power to the antennas, that contains the separate connections to the two antenna coils. The separate connections correspond to the separate antenna input leads 42, 44 of the '862 patent, which connects the integrated signal generator electronics, *i.e.*, the oscillator and driver, to the separate reader antennas 34 and 38, as shown in Fig. 1 of the '862 patent.

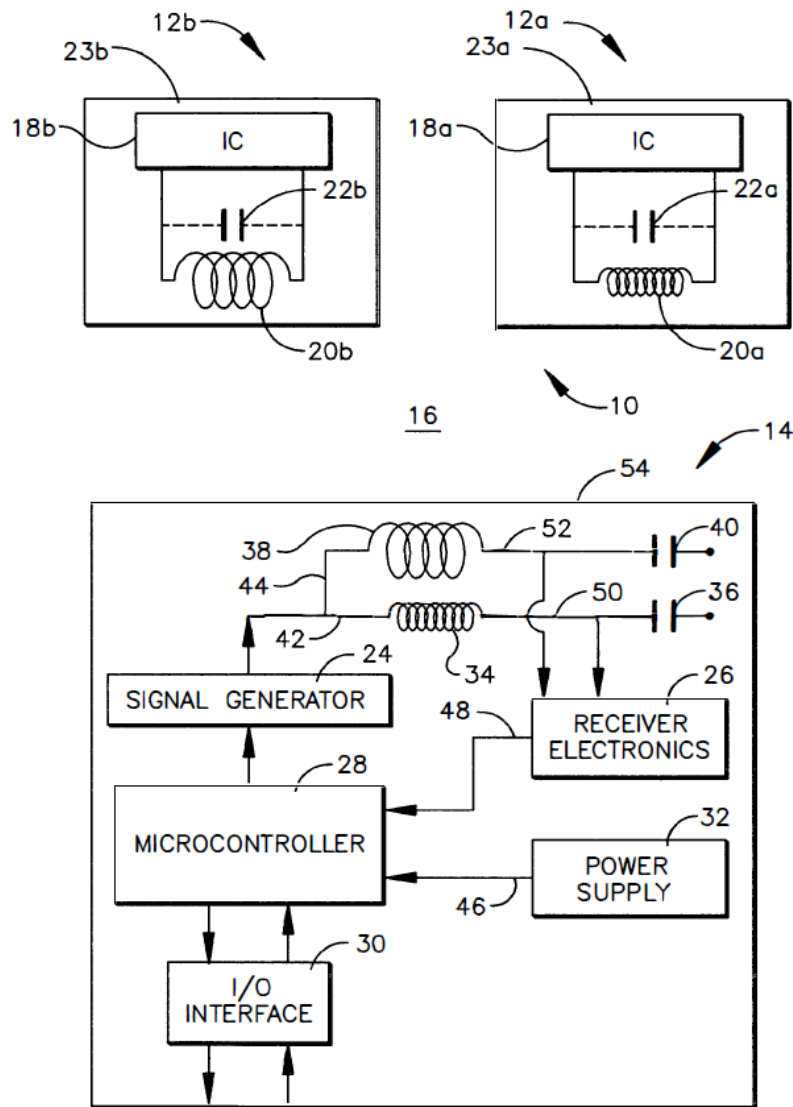


Fig. 1

EX1001, Fig. 1.

261. A POSITA implementing a low frequency antenna into the MIFARE reader would have been motivated to apply the RFID Handbook's teachings described above so that the integrated signal generator electronics would generate signals at the low frequencies described therein as well as 13.56 Mhz. Indeed, the

specific frequency generated by the reader is dependent upon the resistor connected to the oscillator, which sets the output frequency being sent to the antennas. Although the RFID Handbook refers to frequency adjustment in a system of 100-150 kHz, the same principle applies to system of higher frequency: by connecting resistors and enabling frequency adjustment through microcontroller management, the appropriate frequency can be sent to each of the 125 kHz and 13.56 MHz antennas. Indeed, it was known to use integrated oscillators and varying the resistors connected in order to output separate frequencies for multiple antennas.

262. For example, U.S. Patent No. 6,904,796 to Pacsai also teaches the use of an integrated signal generator. *See* EX1021, at 5:23-26 (“Tire positioning tools of the present invention may comprise frequency generating circuitry capable of generating a single frequency or may comprise frequency generating circuitry capable of generating a plurality of different frequencies.”), *id.* at 5:34-37 (“Most commonly, tire positioning tools of the present invention will comprise frequency generating circuitry capable of generating a plurality of different frequencies.”), *id.* at 5:43-57 (“A fourth means for activating tire sensors that can be incorporated into tire positioning tools of the present invention involves the use of a modulated signal. Some tire sensors may be manufactured such that they are activated upon receiving a modulated signal of a particular frequency. Means for generating

modulated signals at a specific frequency are known in the art and any means known in the art can be utilized for generating a modulated signal in tire positioning tools of the present invention. One means for producing a modulated signal in tire positioning tools of the present invention is to include a microprocessor in addition to frequency generating circuitry. As is known in the art, the microprocessor can provide the modulation to the frequency generator circuitry. An amplifier or driver circuit can also be included to amplify the signal.”); *id.* at 5:58-63 (“Similar to the generated CW signal above, tire positioning tools of the present invention may be capable of generating a modulated signal at only a single frequency or may be capable of generating a modulated signal at one of a plurality of frequencies. Different makes of RTMS tire sensors may require different frequencies of modulated signal to be activated.”); *see also id.* at 6:3-12, 6:23-32.

263. Like Pacsai, Great Britain Patent No. 2,305,074, to Howell recognized that “there is no common carrier modulation and data transmission system agreed between manufacturers for such transponders and the systems chosen by different manufacturers of tags and readers vary widely and are generally incompatible with one another.” EX1029, at 15:3-7. “Thus, if the customer’s requirements subsequently change or there are commercial reasons for changing the transponders or tags available from different sources, then a severe costs penalty

will be incurred in duplicating the reader hardware and software support.” *Id.* at 15:16-21. Howell disclosed an apparatus/method “allowing data stored by different manufacturer’s data storage devices to be read.” *Id.* at 16:2-16. Howell further disclosed embodiments that “enable a number of different data storage devices, each using a different modulation and/or data transmission system” (defined to include “the actual carrier frequency and any modulation frequencies,” *id.* at 16:17-24) to be interrogated/read using after Howell’s device identifies the “modulation and data transmission system of the data storage device.” *Id.* at 18:7-16; *see also id.* at 17:20-24. A POSITA would have understood Howell’s disclosure of the ability to “interrogate[]/read” data storage devices at “the actual carrier frequency and any modulation frequency” as teaching an integrated signal generator that can read data storage devices at multiple carrier frequencies.

264. Moreover, an integrated signal generator would have been obvious to try. When implementing a 125 kHz antenna on the PCB of the Philips MIFARE reader, a POSITA would have known that the generation of signals for both antennas could be accomplished in one of two predictable ways—using a single signal generator for both antennas, or using a discrete signal generator for each antenna. Either was a rudimentary and well-known way to allow each antenna to generate a signal, and a POSITA would have had a reasonable expectation of success using either option. Indeed, using integrated signal generators for each

individual frequency was well known in the art before the priority date. *See* EX1008, at 81-88. Moreover, while a POSITA would have known that each design option would present advantages and disadvantages, a POSITA would have known that using discrete signal generators would avoid the additional material cost of including multiple signal generators in a multi-frequency RFID Reader. Thus, a POSITA would have been motivated to try either option.

11. **Claim 16: “The RFID reader of claim 14, wherein said signal generator includes a discrete first signal generator coupled with said first reader antenna for generating signals for transmission from said first reader antenna and a discrete second signal generator coupled with said second reader antenna separate from said discrete first signal generator for generating signals for transmission from said second reader antenna.”**

265. As described for claim 14[D], the Philips MIFARE reader disclosed a signal generator, and 13.56 MHz and 125 kHz carrier frequency signal generators were known in the prior art. *Supra*, §IX.C.9.d. Indeed, the generation of “a signal of the required operating frequency, i.e. 135 kHz *or* 13.56 MHZ [or any other frequency], is generated in the transmitter arm by a stable (frequency) quartz oscillator.” EX1008, at 81 (emphasis added).

266. When implementing the MIFARE reader to include a low-frequency antenna, a POSITA would have known that the generation of signals for both antennas could be accomplished in one of two predictable ways—using a single signal generator for both antennas, or using a discrete signal generator for each

antenna. Either was a rudimentary and well-known way to allow each antenna to generate a signal, and a POSITA would have had a reasonable expectation of success using either option. Indeed, using discrete signal generators for each individual frequency was well known in the art by late 2003. *See* EX1008, at 81-88; EX1009, at 1-2; EX1033, at 1-2; EX1001, at 2:1-36. Moreover, while a POSITA would have known that each design option would present advantages and disadvantages, a POSITA would have known that using a discrete signal generators would avoid the cost of designing an integrated signal generator. Thus, a POSITA would have been motivated to try either option.

12. Claim 17

a. 17[pre]: “An RFID reader for an RFID system comprising:”

267. *See* Claim 14[pre], *supra* § IX.C.9.a.

b. 17[A]: “an antenna array including a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency”

268. *See* Claim 1[A], *supra* § IX.C.3.b. The Philips MIFARE-125 kHz reader combination teach an antenna array. *See* claim 14[C], *infra*.

- c. **17[B] “and second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,”**

269. See Claim 1[B], *supra* § IX.C.3.c.

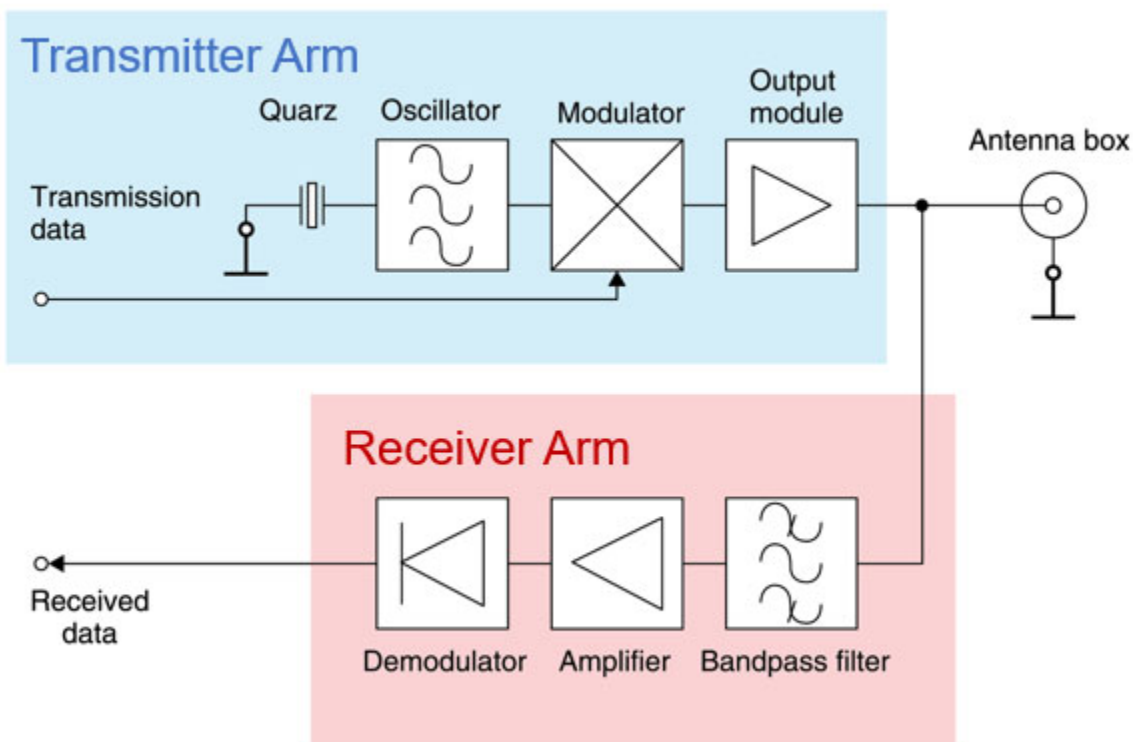
- d. **17[C]: “wherein the first and second antennas are arranged in at least a partially overlapping arrangement along proximate adjacent planes;”**

270. See Claim 5[C], *supra* § IX.C.7.d.

- e. **17[D] “and receiver electronics coupled with said first and second reader antennas.”**

271. The RFID Handbook discloses this limitation. For example, for both the high-frequency MIFARE reader and the low-frequency easy key reader to utilize their antennas to read transponders (i.e., receive a signal), they would have to utilize receiver electronics. See EX1008, at 80-81. Indeed, the RFID Handbook discloses that “[r]eaders in **all systems**” include an “*HF interface*, consisting of a transmitter and **receiver**.” EX1008, at 79 (bolded emphasis added); *see also id.* at 80 (showing the HF interface for the Philips MIFARE reader). Any “data received from the transponder is processed in the *receiver arm*.” EX1008, at 81. The RFID Handbook discloses, for example, that the receiver arm may include a bandpass filter, which filters out the response signal from a transponder, and an amplifier

and a demodulator. EX1008, at 81.



EX1008 at 81 (annotated). Accordingly, the obvious modification of the MIFARE reader to incorporate a low-frequency antenna and associated circuitry to yield a multi-frequency reader, as described above (*supra*, §IX.C.3) would include receiver electronics coupled to both the high-frequency and low-frequency antennas.

13. **Claim 18: “The RFID reader of claim 17, wherein said receiver electronics is integrated receiver electronics including integral means for conditioning signals received by said first and second reader antennas.”**

272. It would have been an obvious modification of the Philips MIFARE-125 kHz combined reader to utilize integrated receiver electronics.

273. Integrated receiver electronics capable of “conditioning signals received by said first and second reader antennas” were well known to the POSITA by late 2003. The ’862 patent describes the function of the receiver electronics as follows:

The receiver electronics 26 ‘condition’ the low and high frequency transponder data signals, thereby placing the signals containing analog and digital data of differing carrier frequencies, data rates and modulation types as recited above into a form which enables the reader microcontroller 28 to properly process the entire range of signals. After conditioning the transponder data signals, the receiver electronics 26 conveys the resulting conditioned transponder data signals to the reader microcontroller 28 via the second microcontroller input 48.

EX1001, at 9:25-34. The ’862 patent does not disclose the specific components that perform these functions.

274. The “conditioning” of received signals of multiple frequencies was an entirely standard procedure by late 2003. *See* EX1008; EX1021; EX1029. For example, combined AM/FM radios, which communicate at in ranges of kHz and MHz, like the ’862 patent (FM between 88.1 MHz to 108.1 MHz; AM between 540 to 1600 kHz), often utilized integrated receiver electronics. It was common to utilize integrated receiver electronics in order condition the signals received into a format that can then be sent to the speaker connected to the antenna, such the transmitted audio comes through the speakers accurately. This is analogous to the function performed by the receiver electronics described in the ’862 patent, but

instead of sending the conditioned output signal to a microcontroller, radios send the conditioned output signal to a speaker system.

275. As another example, the RFID Handbook discloses that in the U2270B reader discussed under Claim 14, *supra* § IX.C.9., input signals from both coils proceed through an amplifier and a Schmitt trigger, which suppresses possible noise and formats the signal, before proceeding to the output, as shown in Figure 11.12.

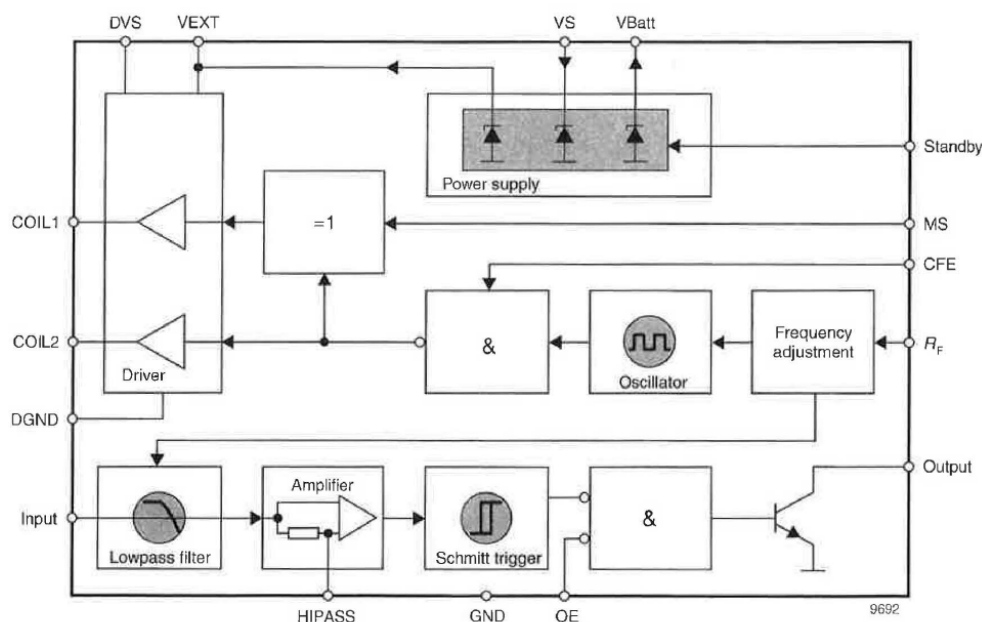


Figure 11.12 Block diagram of the reader IC U2270B. The transmitter arm consists of an oscillator and driver to supply the antenna coil. The receiver arm consists of filter, amplifier and a Schmitt trigger (reproduced by permission of TEMIC Semiconductor GmbH, Heilbronn)

EX1008, at 87; EX1020 at 2, 6. Because, as described under Claim 15, *supra*, the U2270B circuit board generates frequencies between 100 and 150 kHz, the signal received would also be between those frequencies, and all of the signals received are processed through the amplifier and Schmitt trigger.

276. Another example of “integrated receiver electronics” comes from Pascai. Pascai relates to remote tire monitoring systems, which contain sensors that “measure a tire characteristic, most commonly the air pressure in the associated tire, and communicate data corresponding to the tire characteristic to the receiving unit on the vehicle. The data is typically communicated to the receiving unit via radio frequency (“RF”) signals.” EX1021, at 1:18-23. As noted there, “different manufacturers frequently utilize different methods for transmitting data from the tire sensor (upon activation) to the receiving unit,” such as differing frequencies or modulations. *Id.* at 2:38-48. Its disclosure relates to “a tire positioning tool that can be utilized to work with remote tire monitoring systems made by different manufacturers. . . . Preferred tire positioning tools of the present invention are capable of receiving signals of a plurality of frequencies transmitted by activated RTMS tire sensors.” *Id.* at 2:49-64. To achieve this, “[t]he receiving circuitry may comprise a single receiver capable of receiving a single frequency, a single receiver capable of receiving a plurality of frequencies, or multiple receivers each of which is capable of receiving a single frequency.” *Id.* at 7:32-36. This disclosure of “a single receiver capable of receiving a plurality of frequencies” expressly teaches the use of integrated receiver electronics, as claimed.

277. Moreover, the background knowledge of a POSITA discloses this limitation because an integrated signal generator would have been obvious to try.

For example, as described for Ground 1, Claim 17[D], the '667 application disclosed receiver electronics for both 13.56 MHz and 125 kHz reader antennas, and receiver electronics for these carrier frequencies were known in the prior art. *Supra*, § IX.A.12.e. When designing the receiver electronics for the combined 125 kHz-13.56 MHz (Philips MIFARE) reader, a POSITA would have known that the reception of signals by both antennas could be accomplished in one of two predictable ways—using a single receiver electronics for both antennas, or using a discrete receiver electronics for each antenna. Either was a rudimentary and well-known way to allow each antenna to receive a signal, and a POSITA would have had a reasonable expectation of success using either option. Indeed, using integrated receiver electronics for each individual frequency was well known in the art before the priority date. *See* EX1008, at 81-88; EX1020, at 1-2; EX1021, at 7:32-36. Moreover, while a POSITA would have known that each design option would present advantages and disadvantages, a POSITA would have known that using an integrated receiver electronics would avoid the material cost of including multiple sets of receiver electronics in a combined RFID reader. Thus, a POSITA would have been motivated to try either option.

- 14. Claim 19: “The RFID reader of claim 17, wherein said receiver electronics includes discrete first receiver electronics coupled with said first reader antenna for conditioning signals received by said first reader antenna and discrete second receiver electronics coupled with said second reader antenna separate from said discrete first receiver electronics for conditioning signals received by said second reader antenna.”**

278. The RFID Handbook discloses this limitation. For example, as described for claim 17[D], the Philips MIFARE Reader discloses receiver electronics, and 13.56 MHz and 125 kHz carrier frequency receiver electronics were known in the prior art. *Supra*, § IX.C.12.e. When implementing the MIFARE reader to include a low-frequency antenna, a POSITA would have known that the reception of signals by both antennas could be accomplished in one of two predictable ways—using a single receiver electronics for both antennas, or using a discrete receiver electronics for each antenna. Either was a rudimentary and well-known way to allow each antenna to receive a signal, and a POSITA would have had a reasonable expectation of success using either option. Indeed, using discrete receiver electronics for each individual frequency was well known in the art before the priority date. *See* EX1008, at 81-88; EX1009, at 1-2; EX1033, at 1-2; EX1001, at 2:1-36. Moreover, while a POSITA would have known that each design option would present advantages and disadvantages, a POSITA would have known that using a discrete receiver electronics would avoid the cost of designing integrated receiver electronics and would be able to rely on preexisting receiver

electronics to differentiate between the frequencies. Thus, a POSITA would have been motivated to try either option.

15. Claim 20

- a. 20[pre]: “An antenna array for an RFID reader comprising:”**

279. *See* Claim 1[pre], *supra* § IX.C.3.a.

- b. 20[A]: “a first reader loop antenna having a first loop and tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;”**
- c. 20[B]: “and a second reader loop antenna having a second loop and tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,”**

280. The limitations directed to antenna loops are met because the Philips MIFARE antenna described under limitation 1[B] is a loop antenna, and it would have been obvious to use a loop antenna for the low frequency reader antenna, as described in 1[A], *supra* § IX.C.3. For example, loop antennas are conventionally used at 125 kHz and other low frequencies, so it would be obvious to implement the 125 kHz reader antenna on the Philips MIFARE reader as a loop. *See* EX1008, at 9; EX1012; EX1015, at 1, 3; EX1027, at 3-4. Further, loop antennas were well understood in the field of RFID readers to provide an optimal design for the reading of credentials for access control due to the concentrated magnetic field

strength at a distance of a few inches from the reader. EX1008, at 14-35; EX1025, at 6.

- d. **20[C]: “wherein a first plane defined by the first area is substantially orthogonal to a direction of magnetic flux created through the first antenna, wherein a second plane defined by the second area is substantially orthogonal to a direction of magnetic flux created through the second antenna,”¹**

281. The RFID Handbook discloses this limitation. The direction of magnetic flux created by an antenna loop is perpendicular to the plane on which that antenna sits. EX1008, at 15-35; EX1023, at Fig. 2B; EX1025, at 5.

282. A POSITA would have known that two loop antennas in a reader would surround first and second areas, respectively, each of which sits on and defines a separate plane. The direction of magnetic flux created by each antenna is orthogonal to the plane on which that antenna sits. (*See, e.g., id.*) Thus, the multi-frequency reader described above would have a first plane that is substantially orthogonal to a direction of magnetic flux created through the first antenna, and a second plane that is substantially orthogonal a direction of magnetic flux created through the second antenna, as recited in this limitation.

¹ I note that the claim recites “the first area” and “the second area,” but does not give any antecedent basis for these terms.

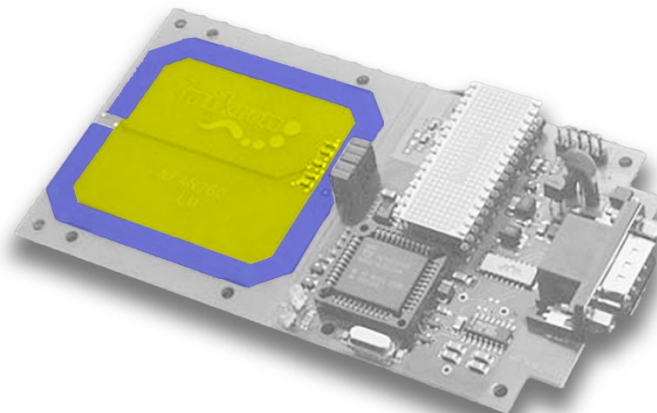
- e. **20[D]: “wherein said first and second loops are arranged relative to one another such that a portion of the first area in the first plane overlaps a portion of the second area in the second plane.”**

283. As described above, a POSITA would have known that it would have been advantageous to implement a low-frequency antenna into the MIFARE reader such that the areas enclosed by each antenna on separate planes overlap. *See supra*, § IX.C.7.

D. Ground 4: The RFID Handbook in view of the Davis Presentation and Walton Renders Obvious Claims 7, 9-11, 13, 22-24, and 26 of the '862 Patent

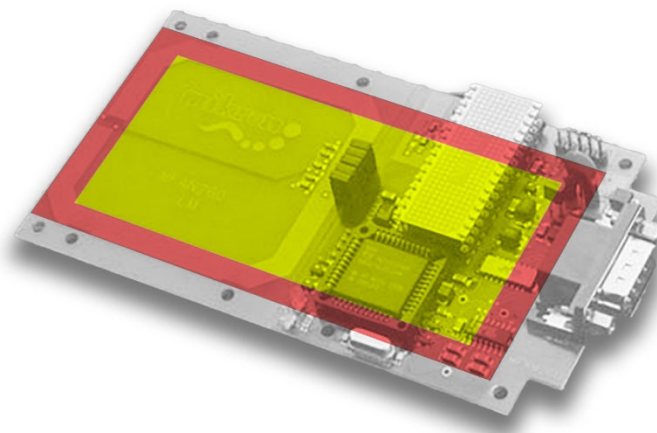
- 1. **Claim 7: “The antenna array of claim 5, wherein said first reader antenna has a first area, said second reader antenna has a second area, and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.**

284. The RFID Handbook discloses this claim. The square loop antenna of the Philips MIFARE system (blue) disclosed by the RFID Handbook encloses a second area, as annotated below in yellow.



EX1008, at 92.

285. Likewise, each of the antenna arrangements described for the low-frequency antenna (**red**) enclose an area, as shown below in **yellow**:



286. It is conventional for each antenna to enclose an area. Indeed, a larger enclosed area by an antenna loop acts to extend the range at which a credential card may be read, such that credentials need not be aligned directly against the

reader antenna, but may instead be a few inches away from the reader. EX1008, at 64, 66, 69, 71, 85; *see also* EX1009, at 2; EX1033, at 2. For example, the RFID Handbook shows in Figure 4.4 how magnetic field strength falls off with distance is a function of antenna radius R :

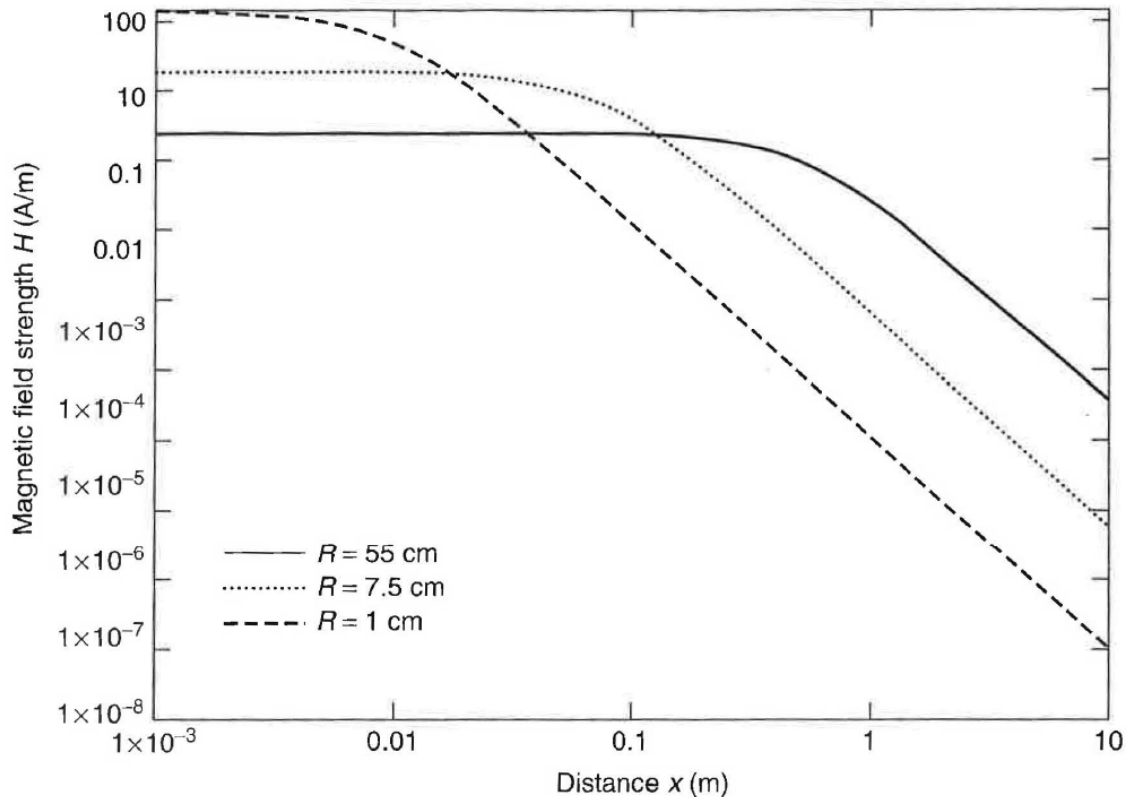


Figure 4.4 Path of magnetic field strength H in the near field of short cylinder coils, or conductor coils, as the distance in the x direction is increased

EX1008, at 17.

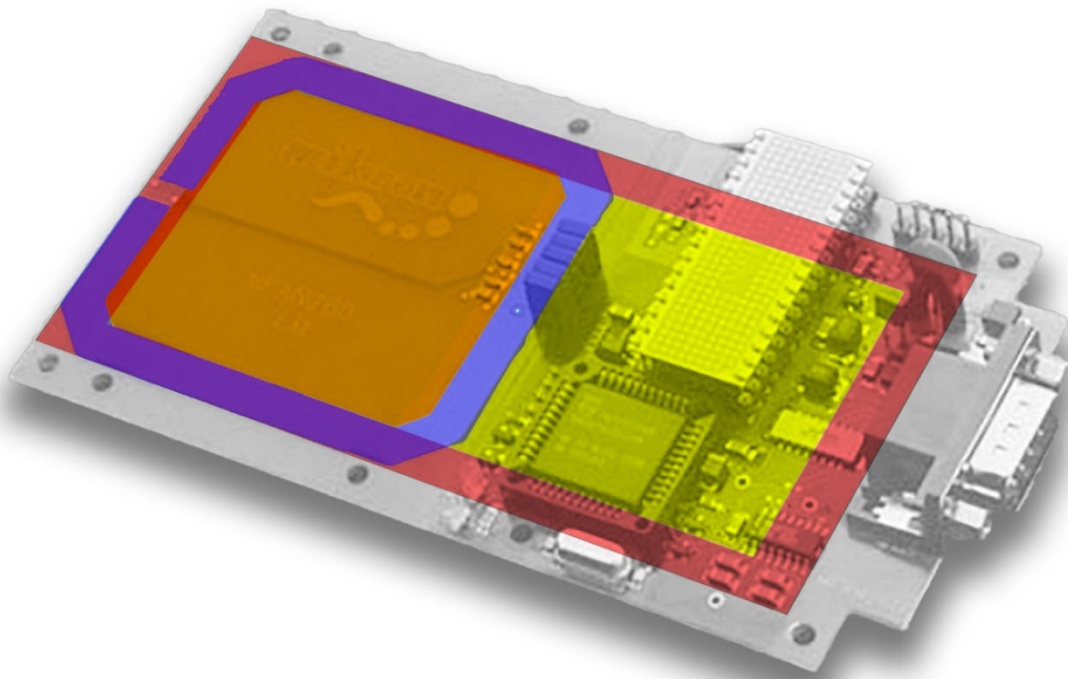
287. A POSITA would have been motivated to arrange the antennas “such that only a portion of said first area aligns with only a portion of said second area” in order to minimize magnetic field interactions between the two reader antennas. A POSITA would have known that any given loop antenna's magnetic fields are

strongest in the area encircled by the loop. This is due to the more concentrated magnetic field lines in that area than outside the antenna in physically small loop antennas. A POSITA seeking to avoid the magnetic field interactions between two antennas sized on the order of a few inches across would therefore be motivated to overlap the antennas such that the magnetic field interactions are balanced and the magnetic flux between the antennas is in an opposing arrangement. The antennas could be reduced further in size to not overlap at all, but decreasing the antenna size further would reduce the read range of each antenna. A POSITA would have known, and it was an elementary concept in RFID design, that a partially overlapping arrangement of two antennas would best balance the objectives of maximizing signal strength while minimizing interference between the two antennas. EX1008, at 61-85; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2.

288. Such an arrangement would have been within the skill of a POSITA to implement, including designing a circuit board, placing the antenna and soldering the connections, and connecting an antenna to a housing with electrical connections to the PCB. These were all rudimentary elements of an RFID reader, well-known in the art, and thus a POSITA would have a reasonable expectation of success in implementing such an arrangement. Indeed, a POSITA would have taken several classes in circuit design, including in radio-frequency circuit design. Further, a POSITA would have been able to design, test, and adjust the placement

of various electrical components as needed in the combined reader through the circuit board and antenna modeling and simulation programs available at the time, as well as through physical prototypes.

289. In sum, it would have been obvious to arrange the low-frequency antenna such that only a portion of the low-frequency antenna area aligns with only a portion of the high-frequency antenna area as recited in Claim 7. The area of overlap is shown in orange, below:



2. **Claim 9**

- a. **9[pre]: “An antenna array for an RFID reader comprising:”**

290. *See* Ground 3, Claim 1[pre], *supra* §IX.C.3.a.

- b. **9[A]: “a first reader antenna tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;”**

291. *See* Ground 3, Claim 1[A], *supra* §IX.C.3.b.

- c. **9[B]: “and a second reader antenna tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency”**

292. *See* Ground 3, Claim 1[B], *supra* §IX.C.3.c.

- d. **9[C]: “wherein said first and second antennas are arranged in an opposing magnetic flux arrangement.”**

293. As described below, this limitation is obvious in view of the RFID Handbook.

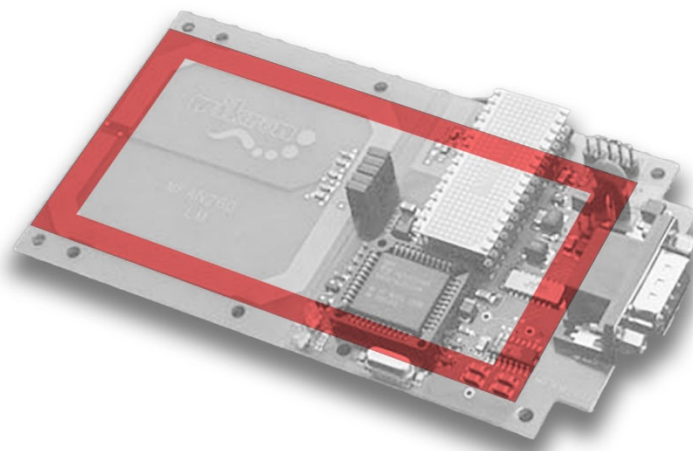
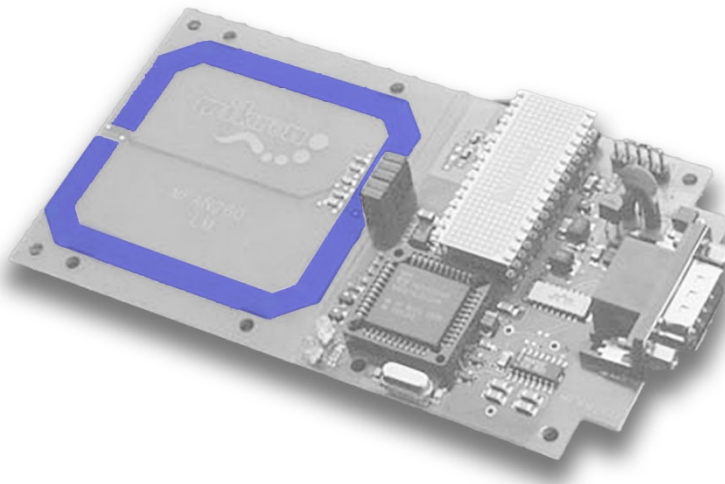
294. It was understood before the by late 2003 that currents flowing through conductor loops (i.e., an antennas) located in the vicinity of one another may affect the magnetic flux of the loops, respectively, and thereby impact reader range. EX1008, at 61-85; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2. I It also was a well-known desire to reduce mutually induced magnetic flux, also referred to as magnetic coupling, so as to reduce any negative impacts to reader performance.

For example, it was known that magnetic coupling could impede read range and could even prevent the reader from reading data sent from a credential due to magnetic field interference by one antenna with the magnetic field transmission from the credential. EX1023, 2:6-36. Thus, a POSITA would have been motivated to implement the combination of a 125 kHz reader and antenna with the 13.56 MHz reader and antenna so as to eliminate any negative impact of magnetic flux, which was routinely accomplished by separating conductors in close proximity as much as practicable. *See* EX1008, 64-65; EX1025, at 1-6.

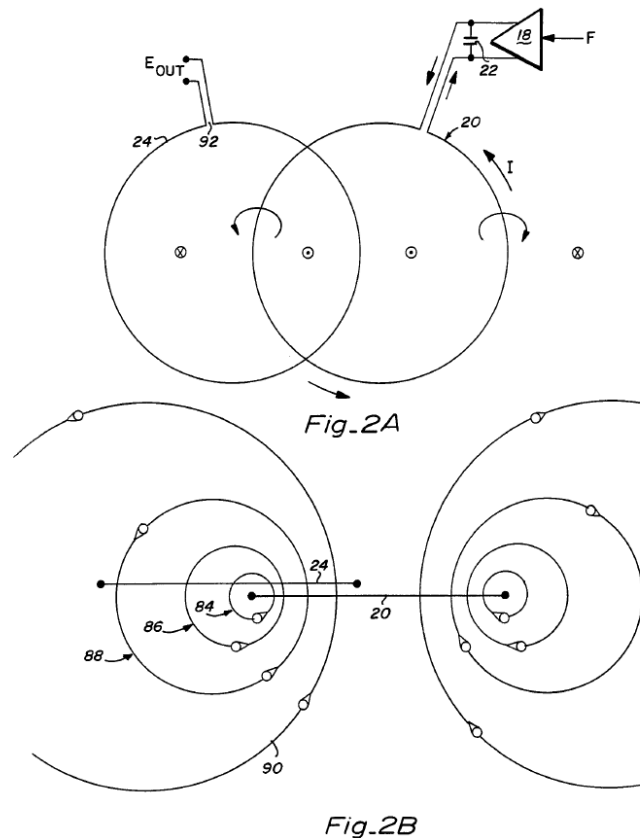
295. In the field of RFID readers, design considerations dictate a small and compact reader housing, as well as a reader face that allows a user to simply and intuitively approach a reader and physically position a credential card near the reader so that it aligns with the internal antenna(s) and their limited range. A POSITA would have considered it an obvious implementation detail to orient the low-frequency reader antenna on the Philips MIFARE antenna to allow for partial antenna overlap (as opposed to complete antenna overlap) ; indeed, a POSITA would have known that this could advantageously and easily be achieved by orienting a smaller area formed by one antenna within a larger area of another other antenna, or by staggering the overlapping antennas. EX1023; EX1024; EX1008. I note that the '862 patent recognizes such orientating results in these

opposing magnetic flux arrangements. '862 Patent, col. 12, ll. 55-58 (Figs. 3A, 3B) and col. 14, ll. 9-30 (Figs. 6A, 6B).

296. As such, and in light of the below, a POSITA would have been motivated to align the reader antennas of the Philips MIFARE-125 kHz reader combination in an opposing magnetic flux arrangement, as shown in the annotated images below, with the top view showing the MIFARE antenna on the top surface of the circuit board, and the bottom view showing the positioning of the low frequency antenna on the lower underside of the circuit board:



297. Walton, filed in 1984, discloses two parallel antennas disposed in a partially overlapping arrangement in order to reduce magnetic flux interference. See EX1023, 5:5-43, Figs. 2A and B. Walton teaches the use of an identification card reader that may be used in connection with access control and security. See *id.*, 1:25-36; 4:5-8; 3:24-29. The reader unit contains two loop antenna coils: “a coil for sending power and a separate coil for receiving data.” 2:56-59; 3:48-59. There is a “partial overlap of the two coils,” as shown in Figs. 2A and 2B below:



Id. 5:11-13; see also *id.* 2:63-66 (“Zero mutual inductance between coil antennas in the reader and between the coil antennas in the identifier is realized by placing coils together with the proper amount of overlap.”); 3:48-59 (“A reader coil

antenna 24 is positioned to be adjacent to and overlap the coil antenna 20”); 1:49-56 (“A reader coil antenna 24 is positioned to be adjacent to and overlap the coil antenna 20”)

298. The two antennas may operate at different frequencies—coil 20 transmitting power at one frequency (F_1) and coil 24 receiving data signals at another, typically lower frequency (F_2). *Id.* 3:34-40 (“The frequency F_1 may be within one of various ranges suitable for transmitting power to the identification section 14. One frequency which has been found to be suitable for F_1 is 13.56 MHz”); 3:67-65 (“Tied across the capacitor 26 is a receiver amplifier 28 which has an automatic frequency control circuit to track a predetermined carrier identification frequency F_2 which is of a value different than frequency F_1 .”); 2:66-67 (“Also, different frequencies may be used in the two directions.”); 4:24-28 (“ . . . The frequency F_2 is typically lower than F_1”).

299. Walton describes ways to align the two antennas, and how the area of overlap of the antenna loops may be adjusted in order to manage and minimize the magnetic flux through the other antenna. With reference to Fig. 2B, Walton describes the effects of antenna alignment on the amount of mutual inductance or induced voltage.

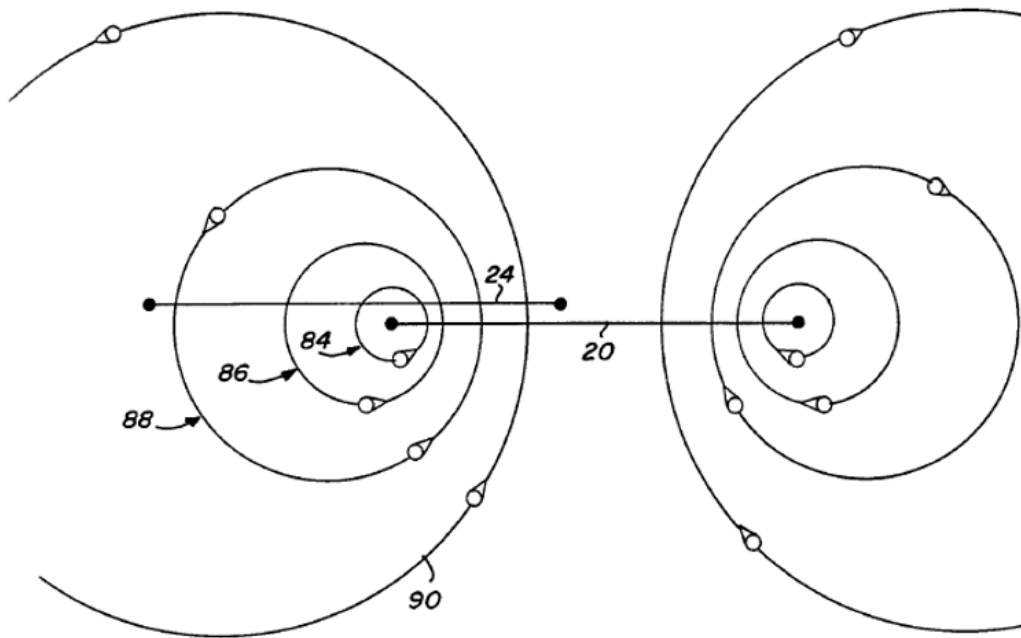


Fig. 2B

Id., Fig. 2B. Walton discloses that “[t]he coil 24 is intersected by the flux lines of fields 84, 86, 88 and 90. The voltage induced in the coil 24 from the coil 20 is proportional to the net flux intersections from the coil 20 through the coil 24. The induced voltage . . . is measured at a gap 92 [(shown in Fig. 2A above)] in the coil antenna 24. The coil antenna 24 is located in FIGS. 2A and 2B where the net flux is close to zero. If the coil 24 were moved further to the left, the upward flux lines 88 and 90 would not intersect the coil 20 whereas their downward values would. This would result in a net downward or negative flux through the coil antenna 24. If the coil antenna 24 is moved further to the right, the downward parts of the flux lines 86 and 88 would no longer intersect the coil antenna 24, but the upward lines of the flux lines 88 and 90 would, for a net upward or positive flux through the coil

antenna 24. The coil antenna 24 is shown judiciously located for zero net flux, or zero mutual inductance. Flux and voltage affects in coil 20 are not coupled to the coil 24. By symmetry, the affects in coil 24 are not induced in the coil antenna 20.”

Id. 5:21-41. Through this teaching, a POSITA would have understood that maximal magnetic flux is reached if the antennas are of identical size and are arranged in an entirely overlapping arrangement, and that a partially overlapping arrangement (either where the antennas both partially overlap each other or where one antenna is entirely encircled by the other) results in reduced magnetic flux, with zero induced voltage being achieved where an antenna symmetrically intersects the positive and negative magnetic flux of the other antenna.

300. Indeed, Walton directly teaches that “**symmetry**” in the positioning of one antenna with respect to the magnetic field lines of the other antenna results in “zero mutual inductance,” because both downward and upward flux lines 88, 86 intersect the coil antenna 24, as shown in Fig. 2B. EX1023, at 5:36-40 (bolded emphasis added); see also *id.* at 5:32-36 (“If the coil antenna 24 is moved further to the right, the downward parts of the flux lines 86 and 88 would no longer intersect the coil antenna 24, but the upward lines of the flux lines 88 and 90 would, for a net upward or positive flux through the coil antenna 24.”).

301. I note that these disclosures from Walton directly teach the “opposing magnetic flux arrangements” shown in Figs. 3 and 6 of the ’862 patent, which are described as being opposing magnetic flux arrangements.

302. For example, these disclosures from the much-earlier Walton patent are precisely what the ’862 patent describes with respect to its Figures 6A and 6B:

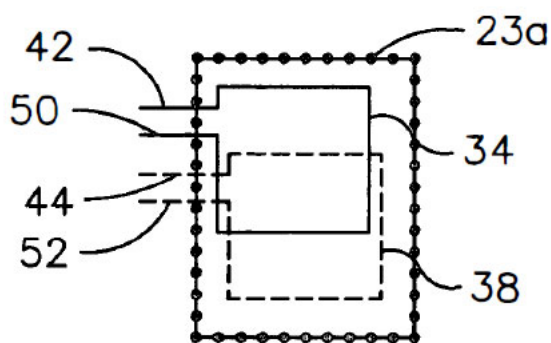


Fig. 6A

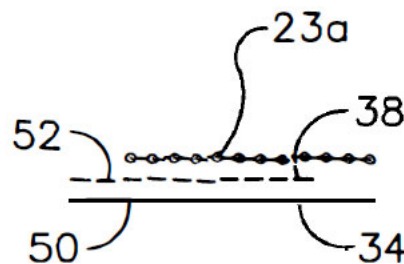


Fig. 6B

Ex. 1001, Figs. 6A, 6B. The “’862 patent discloses that an “opposing magnetic flux arrangement” where “reader antennas 34, 38 are arranged relative to one another such that essentially half the total area of the reader low frequency antenna 34 aligns with essentially half the total area of the reader high frequency antenna 38.” *Id.* at 13:61-14:2. In this arrangement, “[t]he same magnitude of magnetic flux generated by the reader low frequency antenna 34 in the positive and negative directions passes through the reader high frequency antenna 38 and similarly the

same magnitude of magnetic flux generated by the reader high frequency antenna 38 in the positive and negative directions passes through the reader low frequency antenna 34,” which causes the magnetic fluxes to “cancel out essentially in their entirety.” EX1001, at 14:9-20. As described above, Walton disclosed this same solution to minimizing magnetic flux approximately 20 years before the ’862 patent.

303. Similarly, Walton teaches the opposing magnetic flux arrangement recognized in Figures 3A and 3B of the ’862 patent. Just as reader antenna coil 24 intersects both downward and upward flux when oriented on the right side of the antenna coil 20, antenna coil 24 would also experience net zero magnetic flux if it were oriented such that it overlapped the entirety of antenna coil 20—because the upward and downward flux originating from each of the right and left portions of antenna coil would cancel out across the entirety of the extended antenna coil 24, as shown below where antenna coil 24 (red) is modified to overlap the entirety of antenna coil 20.

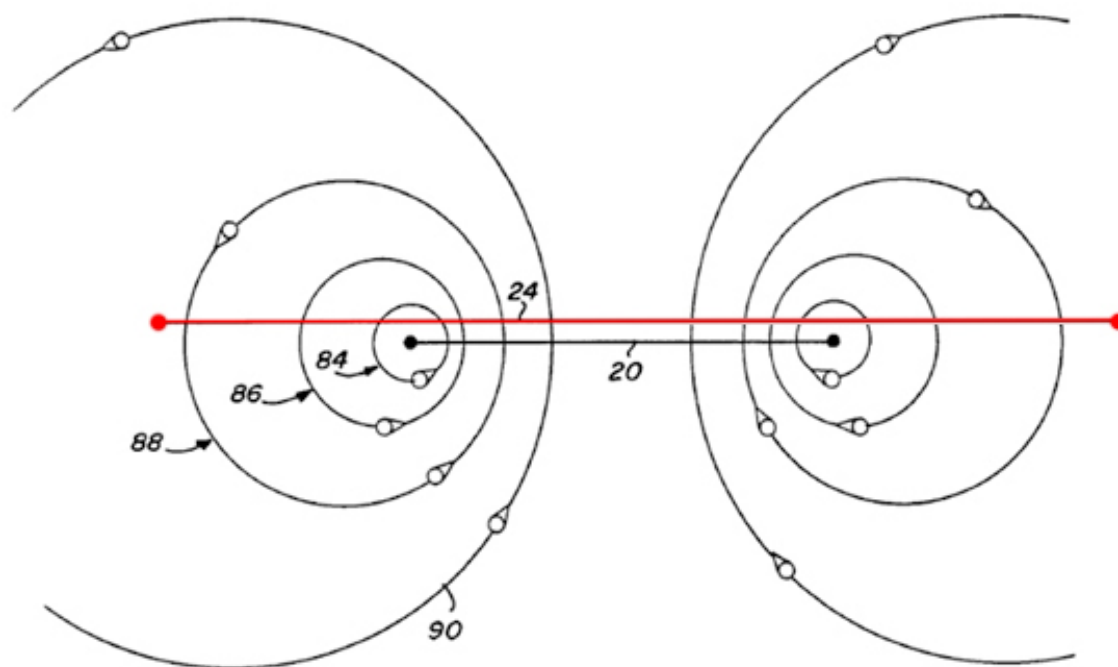


Fig. 2B

See EX1023, at 5:21-43. This results in an arrangement where coil 24, which receives signals at a lower frequency than the frequency by which the coil 20 transmits signals, completely encircles coil 20. A POSITA would have understood that this teaches the “opposing magnetic flux arrangement” disclosed with reference to Figs. 3A and 3B of the ’862 patent, where “[t]he reader antennas 34, 38 are arranged relative to one another such that the area of the reader high frequency antenna 38 fits entirely within the area of the reader low frequency antenna 34” and the magnetic flux passing through the low frequency antenna 34.” EX1001, 12:36-44. “As a result [of this arrangement], the positive and negative magnetic fluxes generated by the reader high frequency antenna 38, which pass

through the reader low frequency antenna 34, cancel out, summing to essentially zero.” *Id.* at 12:52-55.

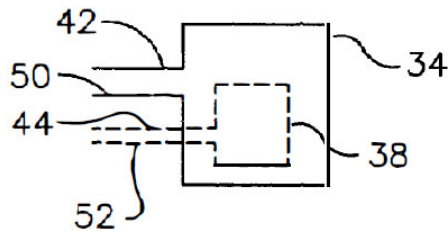


Fig. 3A

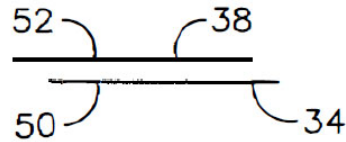
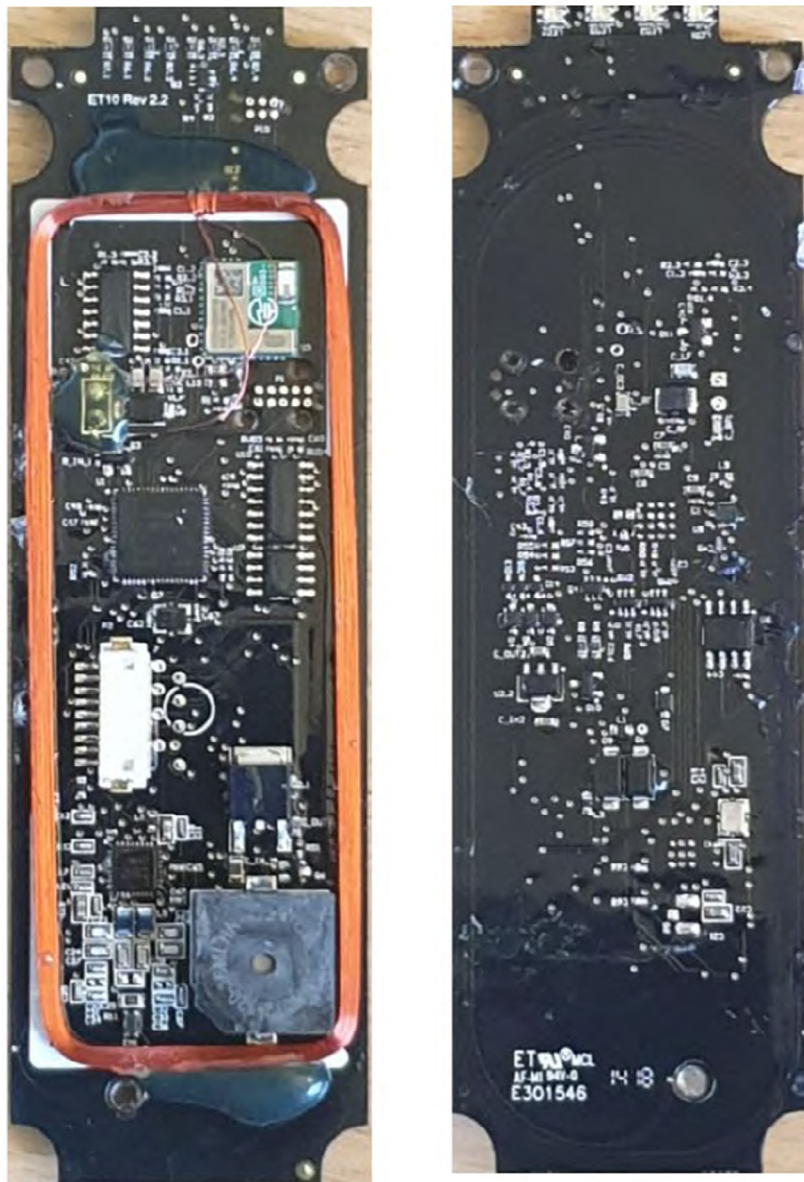


Fig. 3B

304. Moreover, Patent Owner’s infringement contentions allege that the “opposing magnetic flux arrangement” is met where “the low frequency antenna is surrounded by the area of the second high frequency antenna, both positive and negative magnetic flux from the low frequency antenna will necessarily pass through the high frequency reader antenna” and “low frequency antenna on back [of circuit board] shown entirely within area of high frequency antenna on the front of the reader.” EX1030, at pgs. 40-41.



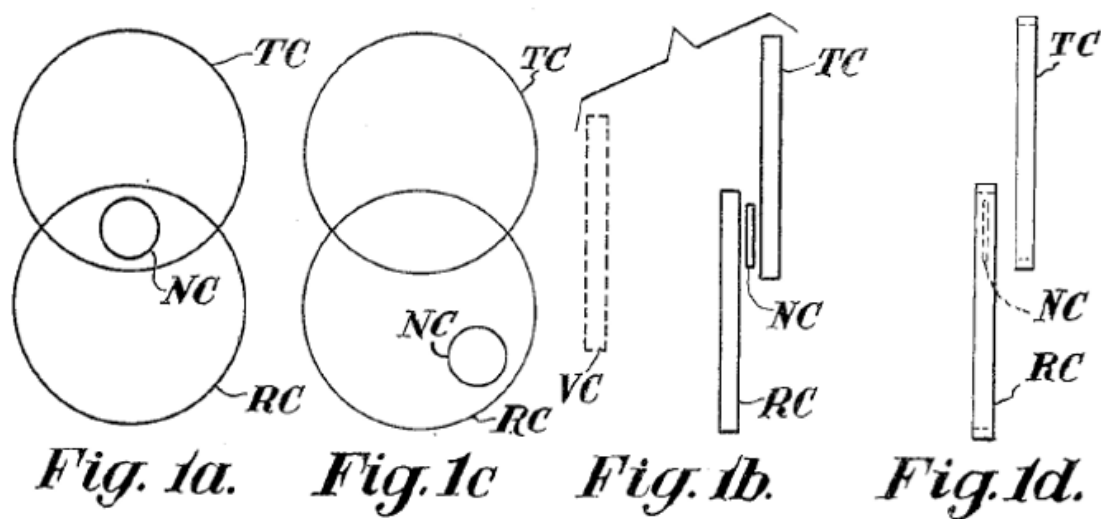
Id. at 40. Walton discloses this same behavior, as described above, and that the Philips MIFARE-13.56 MHz reader combination discloses the high frequency reader antenna entirely encircled by the 125 kHz reader antenna, just as the antenna on the left is entirely encircled by the antenna embedded on the circuit board on the right.

305. A POSITA implementing the MIFARE reader to include a low frequency antenna would have been motivated to look to Walton’s teachings described above. Walton is directed to the same objectives as the readers disclosed in the RFID Handbook—providing a reader for access control with strong signal strength and providing an understanding of magnetic fields in RFID Readers (EX1023, at 3:48-56, 4:9-5:43; EX1008, at 14-35)—and Walton’s teachings regarding antenna orientation are consistent with the RFID’s teachings of minimizing magnetic flux. A POSITA would have known that Walton’s teachings could be easily implemented with the MIFARE reader and a low frequency antenna, and would have been motivated to apply these teachings to minimize magnetic flux between the two antennas while allowing for a compact reader housing and strong signal strength between the reader and cards operating at either high or low frequencies.

306. Indeed, these concepts go back decades. For example, U.S. Patent No. 2,779,908 (the ’908 patent), filed in 1952, also discloses antennas in an “opposing magnetic flux arrangement.” The ’908 patent recognizes that a minimal area of overlap for “relatively large diameter,” air-core antennas should “normally [result in] no magnetic coupling from one coil to the other” EX1024, 1:32, 2:58-60; *see also id.*, 1:31-40 (“[I]t has been found that when air-core coils of relatively large diameter are involved, and the coils are arranged so as to overlap one another

as a result of the coils being placed in close proximity, it is not possible to reduce the coupling to zero by placing the coils [at an angle with respect to each other]. In this case, the coupling between the coils is reduced by overlapping the coils so that about 20% of their diameter are overlapped, but it has been found that some coupling usually still exists even with this placement.”); 2:48-3:2.

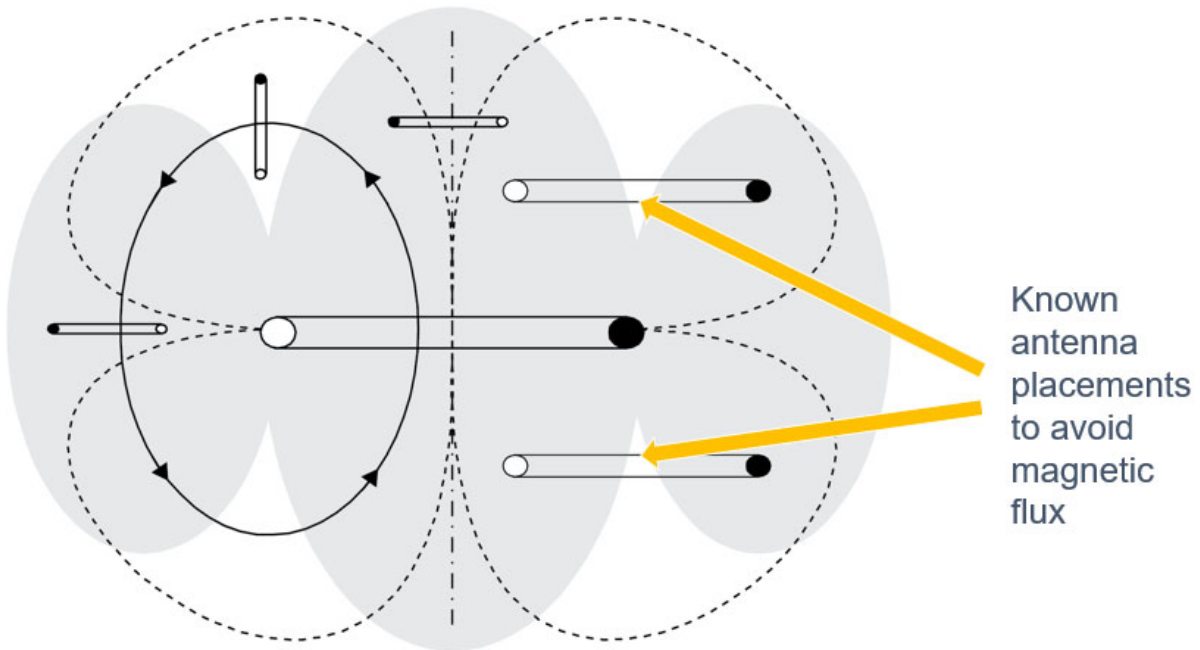
307. Figures 1a through 1d of the '908 patent disclose a “transmitting coil TC and receiving coil RC ... disposed in such manner that the coils are aligned vertically and ... overlapped to about 20% of their diameters”:



Id. at 2:48-57. The '908 patent discloses that this arrangement of coils should normally prevent any “magnetic coupling from one coil to the other.” *Id.* at 2:58-60. The '908 patent further notes that while it has been found that a small amount of coupling may nonetheless exist, this can be solved by introduction of a neutralizing coil. *See id.* at 2:61-3:2 (“However, it has been found that a small

amount of coupling usually exists, presumably due to the geometry of the coils and small amounts of current-carrying material in the coil construction [T]he introduction of a neutralizing coil [NC] which may consist of a single short-circuited turn of suitable diameter and resistance when properly positioned with respect to the transmitting and receiving coils, will reduce the coupling normally existing between the two coils to an amount that cannot be detected by the usual laboratory instruments.”).

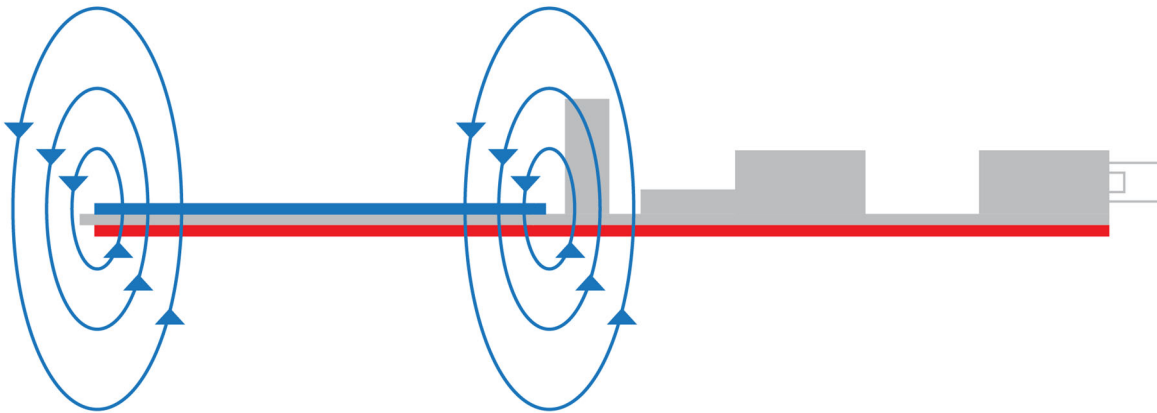
308. Additionally, the RFID Handbook shows the interrogation zone around a reader loop antenna based on the orientation of a transponder antenna coil to the reader coil. The interrogation zone refers to the “bending of the *magnetic field lines* in the entire area around the reader coil” where, at various angles, a transponder may be read. EX1008, at 84-85 (emphasis original). As shown in the gray circles, the interrogation zone—and thus magnetic field strength—is strongest in the area encircled by the antenna. The RFID Handbook teaches that if a second reader antenna were to be placed in a parallel with the reader antenna of Figure 4.24, the second antenna would experience the highest amount of magnetic coupling if it were placed such that the area of both antennas completely overlap, but the antennas would experience less coupling if the antennas only partially overlapped, as shown in the annotated Figure 4.24 below.



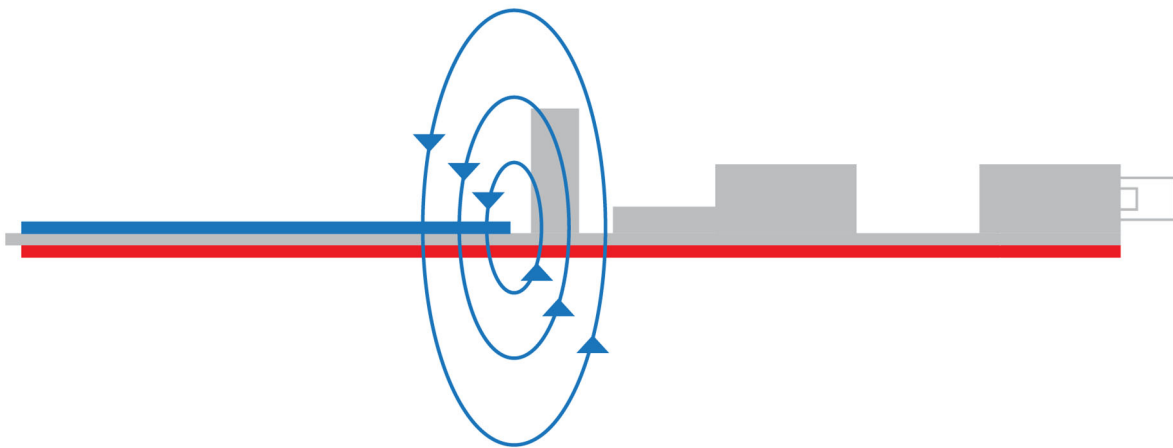
EX1008, at 85.

309. In sum, a POSITA would have understood from Walton's teachings that completely overlapping two antennas would have resulted in maximal magnetic inductance due to the high amount of positive magnetic flux. *See* EX1023, at 5:21-42; *see also* EX1024, 1:31-40; 2:48-52; EX1008, 84-85. A POSITA would have known to reduce the total magnitude of magnetic flux by therefore aligning the antennas in a partially overlapping arrangement (as opposed to complete antenna overlap). *Id.* Although having zero antenna overlap would reduce magnetic flux even further, a POSITA would have known that having two antennas in a non-overlapping orientation would have resulted in an undesirable larger total reader size, as the '862 patent recognizes *See* EX1001, at 11:46-65.

310. If a second reader antenna were to be placed in a parallel with the reader antenna of Figure 4.24, the second antenna would experience the highest amount of magnetic coupling if it were placed such that the area of both antennas completely overlap, but the antennas would experience less coupling if the antennas only partially overlapped, as shown below with reference to the modification where the MIFARE reader includes a 125 kHz antenna embedded on the underside of the circuit board. Here the magnetic flux generated by the MIFARE 13.56 antenna (blue) passes through the 125 kHz antenna (red). The magnetic flux generated at the righthand side of the 13.56 MHz antenna cancels out across the 125 kHz antenna because both upward and downward facing flux pass through the 125 kHz antenna, leaving only the induced voltage generated by the left-hand side of the flux from the 13.56 MHz antenna through the 125 kHz antenna.



311. Of note, as shown below, magnetic flux generated by the 13.56 MHz antenna that is directed in both the upwards and downwards directions passes through the 125 kHz antenna, so the directions of magnetic flux across the 125 kHz antenna are opposing, and this arrangement of antennas provides an opposing magnetic flux arrangement.



312. In sum, a POSITA would have understood from Walton's teachings that completely overlapping two antennas would have resulted in maximal magnetic inductance due to the high amount of positive magnetic flux. *See* EX1023, at 5:21-42; *see also* EX1024, 1:31-40; 2:48-52; EX1008, 84-85. A POSITA would have known to reduce the total magnitude of magnetic flux by therefore aligning the antennas in a partially overlapping arrangement (as opposed to complete antenna overlap). *Id.* Although having zero antenna overlap would reduce magnetic flux even further, a POSITA would have known that having two

antennas in a non-overlapping orientation would have resulted in an undesirable larger total reader size, as the '862 patent recognizes *See* EX1001, at 11:46-65.

313. Accordingly, a POSITA implementing the MIFARE reader to include a low frequency antenna would have been motivated to orient the antennas such that the 125 kHz antenna and the 13.56 MHz antennas would be arranged in an opposing magnetic flux arrangement, as recited in claim 9 of the '862 patent.

3. Claim 10: “The antenna array of claim 9, further comprising a reader housing containing said first and second antennas.”

314. *See* Ground 3, Claim 4, *supra* §IX.C.6.

4. Claim 11:

a. 11[A]: “The antenna array of claim 9, wherein said first reader antenna has a first area, said second reader antenna has a second area”

315. *See* Claim 7, *supra* §IX.D.1.

b. 11[B]: “and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”

316. *See* Claim 7, *supra* §IX.D.1.

5. Claim 13: “The antenna array of claim 9, wherein said first and second reader antennas are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.”

317. The RFID Handbook, in view of the background knowledge of a POSITA, teaches this claim. Indeed, the arrangements described above with

respect to Claim 9 are a subset of the overlapping arrangements described under Ground 3, Claim 5[C]. *See supra*, §§IX.D.9, IX.C.d.

6. Claim 22:

a. “The antenna array of claim 20,”

318. As discussed above, the RFID Handbook in view of the Davis Presentation renders claim 20 obvious. *Supra*, §IX.C.15.

b. “wherein said first and second loops have a parallel orientation and are arranged relative one another such that a size of the portion of the first area aligning with the portion of the second area is less than at least one of a size of the first area and a size of the second area.”

319. As shown and described above, it would have been obvious to implement low- and high-frequency loop antennas into the MIFARE reader and two orient the two antennas in one of three ways known to provide advantages (embedded on the underside of the circuit board, attached to a surface of the circuit board, or attached along the perimeter of the housing). *Supra*, §IX.C.1.d. With any of these implementations, the two loop antennas would have a parallel orientation and would be arranged relative to one another such that the portion of the first area aligning with the portion of the second area is less than at least one of a size of the first area and a size of the second area, as recited in this limitation. Moreover, a POSITA would have been motivated to arrange the antennas in this manner, as it was well known that such an arrangement would have provided

several advantages, including reduced magnetic flux interference, miniaturization and compactness, and the fine-tuning of magnetic flux to specific directions. *See* EX1008, at 61-85; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2.

320. Indeed, as discussed with respect to claim 9, it was understood by late 2003 that currents flowing through conductor loops (i.e., antennas) located in the vicinity of one another may affect the magnetic flux of the loops, respectively, and thereby impact reader range. EX1008, at 61-85; EX1023, 5:21-43; EX1024, 1:31-40, 2:48-3:2. It also was a well-known desire to reduce mutually induced magnetic flux, also referred to as magnetic coupling, so as to reduce any negative impact to reader performance, such as read range and ability to read credentials due to magnetic field interference by one antenna with the magnetic field transmission from the credential, which contains data. EX1023, 2:6-36; *see id.* at 422-36. Thus, a POSITA would have been motivated to implement the 125 kHz antenna on the Philips MIFARE reader board so as to eliminate any negative impact of magnetic flux, which was routinely accomplished by separating conductors in close proximity as much as practicable. *See* EX1008, 64-65; EX1025, at 1-6.

321. In the field of RFID readers, where design considerations dictate a small and compact reader housing, as well as a reader face that allows a user to simply and intuitively approach a reader and physically position a credential card

near the reader so that it aligns with the internal antenna(s) and their limited range, it would have been an obvious implementation detail to design the Philips MIFARE-125 kHz combined reader to have partial antenna overlap (as opposed to complete antenna overlap), which could be achieved by be achieved by orienting a smaller area formed by one antenna within a larger area of another other antenna or staggering the overlapping antennas. EX1023; EX1024; EX1008. Indeed, the ‘862 patent recognizes such orientating results in these opposing magnetic flux arrangements. ‘862 Patent, col. 12, ll. 55-58 (Figs. 3A, 3B) and col. 14, ll. 9-30 (Figs. 6A, 6B). Therefore, claim 22 is obvious in view of the RFID Handbook.

7. Claim 23

a. 23[pre]: “An antenna array for an RFID reader comprising:”

322. *See* Ground 3, Claim 1[pre], *supra* §IX.C.15.a.

b. 23[A]: “a first reader loop antenna having a first loop and tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;”

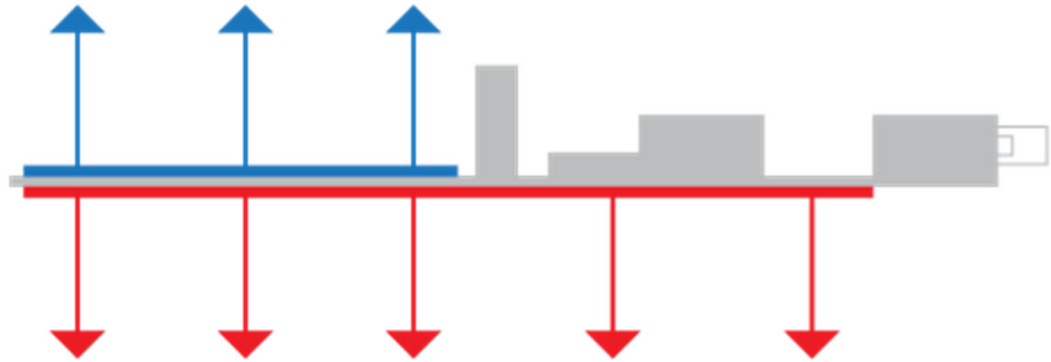
323. *See* Ground 3, Claim 20[A], *supra* §IX.C.15.b.

c. 23[B]: “and a second reader loop antenna having a second loop and tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,”

324. *See* Ground 3, Claim 20[B], *supra* §IX.C.15.c.

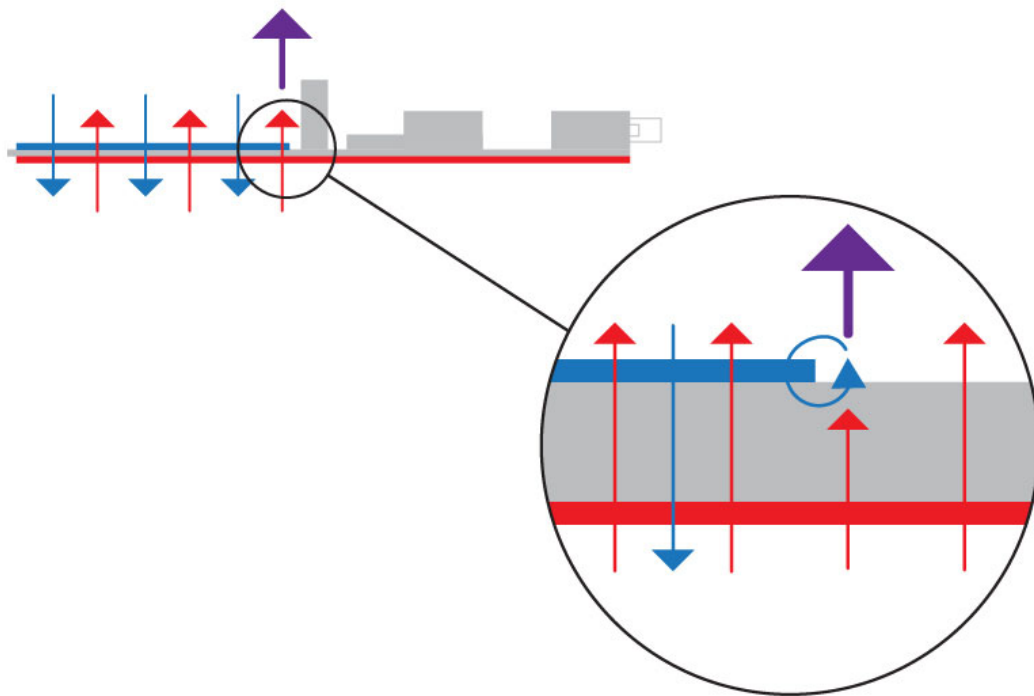
- d. **23[C]: “wherein said first and second loops are arranged in an opposing magnetic flux arrangement where the direction of magnetic flux created through the first loop is substantially parallel but opposite to the direction of magnetic flux created through the second loop.”**

325. As described above, it would have been obvious to orient the 13.56 MHz and 125 kHz antennas in a parallel orientation. *Supra*, §IX.C.3. In this parallel arrangement, the direction of magnetic flux generated by each antenna is perpendicular to the plane on which the generating antenna sits. When the antennas are aligned in parallel, the directions of magnetic flux from each antenna would also thereby be in parallel with each other. *Id.* Opposing directions of magnetic fields are created by opposing directions of currents in the antennas, and there are only two directions the current can flow in a wire, rendering this limitation obvious. *Id.* For example, as shown below, the field lines from the MIFARE antenna (blue), point in opposite directions to the field lines of the low-frequency reader antenna (red):



326. Moreover, in certain circumstances, it is beneficial to arrange two antenna loops “in an opposing magnetic flux arrangement where the direction of magnetic flux created through the first loop is substantially parallel but opposite to the direction of magnetic flux created through the second loop.” As described above with respect to Claim 9[C], a POSITA would have been motivated to arrange the antennas in an opposing magnetic flux arrangement. If the antennas are arranged such that the current in one antenna flows in the opposite direction of the current in the other antenna, then the non-overlapping portion of each antenna

experiences *constructive* magnetic interference, which has the positive effect of increasing the magnetic strength, and thus read range, of each antenna at the portion of non-overlap. From the side-profile view below of the arrangement shown in Claim 9[C], the flux that curves around the exterior portion of the blue 13.56 MHz antenna wire runs in the same direction as the magnetic field for the red 125 kHz antenna, which has a magnetic field pointing the other direction. This strengthens the magnetic field of the red antenna, the strengthened portion exemplified in purple.



8. **Claim 24: “The antenna array of claim 23, wherein said first loop has a first area, said second loop has a second area, and said first and second loops are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.”**

327. *See* Claim 7 *supra*, §IX.D.1.

9. **Claim 26: “The antenna array of claim 23, wherein said first and second loops are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.”**

328. *See* Claim 13, *supra*, §IC.D.5.

329. I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

330. I declare under penalty of perjury that the foregoing is true and correct.

Dated: March 23, 2023



Emmanouil M. Tentzeris, Ph.D.

X. CLAIM LISTING

The following claim listing assigns element labels (e.g., 1[A], 1[B], etc.) to certain claims for clarity.

Claim 1
1[pre] An antenna array for an RFID reader comprising:
1[A] a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency;
1[B] and a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,
1[C] wherein the first and second antennas are oriented along axes that are substantially parallel to one another.
Claim 2
2. The antenna array of claim 1, wherein said first low carrier frequency is nominally 125 kHz.
Claim 3
3. The antenna array of claim 2, wherein said second high carrier frequency is about 13.56 MHz.
Claim 4
4. The antenna array of claim 1, further comprising a reader housing containing said first and second antennas.
Claim 5
5[pre] An antenna array for an RFID reader comprising:
5[A] a first reader antenna tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;
5[B] and a second reader antenna tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,
5[C] wherein said first and second antennas are arranged in at least a partially overlapping arrangement on proximate adjacent planes.
Claim 6

6. The antenna array of claim 5, further comprising a reader housing containing said first and second antennas.
Claim 7
7. The antenna array of claim 5, wherein said first reader antenna has a first area, said second reader antenna has a second area, and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.
Claim 9
9[pre] An antenna array for an RFID reader comprising:
9[A] a first reader antenna tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;
9[B] and a second reader antenna tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,
9[C] wherein said first and second antennas are arranged in an opposing magnetic flux arrangement.
Claim 11
11[A] The antenna array of claim 9, wherein said first reader antenna has a first area, said second reader antenna has a second area,
11[B] and said first and second reader antennas are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.
Claim 13
13. The antenna array of claim 9, wherein said first and second reader antennas are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.
Claim 14
14[pre] An RFID reader for an RFID system comprising:
14[A] an antenna array including a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency
14[B] and a second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,
14[C] wherein the first and second antennas are oriented along axes that are substantially parallel to one another;

14[D] and a signal generator coupled with said first and second reader antennas.
Claim 15
15. The RFID reader of claim 14, wherein said signal generator is an integrated signal generator including integral means for generating signals for transmission from said first and second reader antennas.
Claim 16
16. The RFID reader of claim 14, wherein said signal generator includes a discrete first signal generator coupled with said first reader antenna for generating signals for transmission from said first reader antenna and a discrete second signal generator coupled with said second reader antenna separate from said discrete first signal generator for generating signals for transmission from said second reader antenna.
Claim 17
17[pre] An RFID reader for an RFID system comprising:
17[A] an antenna array including a first reader antenna tuned to operate at a first low carrier frequency enabling data communication with a first transponder transmitting data signals at said first low carrier frequency
17[B] and second reader antenna tuned to operate at a second high carrier frequency different from said first low carrier frequency enabling data communication with a second transponder transmitting data signals at said second high carrier frequency,
17[C] wherein the first and second antennas are arranged in at least a partially overlapping arrangement along proximate adjacent planes;
17[D] and receiver electronics coupled with said first and second reader antennas.
Claim 18
18. The RFID reader of claim 17, wherein said receiver electronics is integrated receiver electronics including integral means for conditioning signals received by said first and second reader antennas.
Claim 19

19. The RFID reader of claim 17, wherein said receiver electronics includes discrete first receiver electronics coupled with said first reader antenna for conditioning signals received by said first reader antenna and discrete second receiver electronics coupled with said second reader antenna separate from said discrete first receiver electronics for conditioning signals received by said second reader antenna.

Claim 20

20[pre] An antenna array for an RFID reader comprising:

20[A] a first reader loop antenna having a first loop and tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;

20[B] and a second reader loop antenna having a second loop and tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,

20[C] wherein a first plane defined by the first area is substantially orthogonal to a direction of magnetic flux created through the first antenna, wherein a second plane defined by the second area is substantially orthogonal to a direction of magnetic flux created through the second antenna,

20[D] wherein said first and second loops are arranged relative to one another such that a portion of the first area in the first plane overlaps a portion of the second area in the second plane.

Claim 21

21. The antenna array of claim 20, wherein the directions of magnetic flux created through the first and second antennas are not orthogonal.

Claim 22

22. The antenna array of claim 20, wherein said first and second loops have a parallel orientation and are arranged relative one another such that a size of the portion of the first area aligning with the portion of the second area is less than at least one of a size of the first area and a size of the second area.

Claim 23

23[pre] An antenna array for an RFID reader comprising:

23[A] a first reader loop antenna having a first loop and tuned to operate at a first carrier frequency enabling data communication with a first transponder transmitting data signals at said first carrier frequency;

23[B] and a second reader loop antenna having a second loop and tuned to operate at a second carrier frequency different from said first carrier frequency enabling data communication with a second transponder transmitting data signals at said second carrier frequency,
23[C] wherein said first and second loops are arranged in an opposing magnetic flux arrangement where the direction of magnetic flux created through the first loop is substantially parallel but opposite to the direction of magnetic flux created through the second loop.
Claim 24
24. The antenna array of claim 23, wherein said first loop has a first area, said second loop has a second area, and said first and second loops are arranged relative one another such that only a portion of said first area aligns with only a portion of said second area.
Claim 26
26. The antenna array of claim 23, wherein said first and second loops are arranged in an overlapping arrangement simultaneous with said opposing magnetic flux arrangement.